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RESEARCH & DEVELOPMENT

PROJECT SUMMARIES

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NAVAL AIR WARFARE CENTER
TRAINING SYSTEMS DIVISION
12350 Research Parkway
Orlando, Florida 32826-3224

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This brochure presents brief summaries of the FY94 research efforts at the Naval Training Systems Center (NAVTRASYSCEN) in Orlando, FL. NAVTRASYSCEN has comprehensive simulation and training systems responsibilities ranging from research and technology base development through system acquisition and life cycle support. The NAVTRASYSCEN is unique in this integrated role because it performs research, specifies the training device's engineering, instructional, and operational requirements, selects the contractor, evaluates the trainer as it is being built, and ensures the trainer can be properly operated and maintained in the field. In addition to the Navy, NAVTRASYSCEN provides services for the Marine Corps, Army, Air Force, and foreign governments. The NAVTRASYSCEN's research mission is to plan and perform a full range of directed research and development in support of Naval training systems for all warfare areas and platforms, to maintain an expanding technology base, and to transition research results to the fleet. R&D program emphasis is on fleet and training command requirements, rapid transition of products, industry/university coordination, improved planning, coordination with other services, and improved quality and cost effectiveness of products.

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EXECUTIVE SUMMARY

On 1 October 1993, the Naval Training Systems Center was reestablished as the Naval Air Warfare Center Training Systems Division (NAVAIRWARCENTRASYSDIV). It has comprehensive simulation and training systems responsibilities, ranging from research and technology base development through system acquisition and life cycle support. The NAVAIRWARCENTRASYSDIV is unique in this integrated role because it performs research, specifies the training device's engineering, instructional, and operational requirements, selects the contractor, evaluates the trainer as it is being built, and ensures the trainer can be properly operated and maintained in the field. In addition to its mission as the principal Navy activity for development of training systems, NAVAIRWARCENTRASYSDIV provides services for the Marine Corps, Army, Air Force, and foreign governments.

The NAVAIRWARCENTRASYSDIV's research mission is to plan and perform a full range of directed research and development in support of Naval training systems for all warfare areas and platforms, to maintain an expanding technology base, and to transition research results to the fleet. R&D program emphasis is on fleet and training command requirements, rapid transition of products, industry/university coordination, improved planning, coordination with other services, and improved quality and cost effectiveness of products. Needs for naval service training systems are determined by the warfare area sponsors for training and training systems under the Chief of Naval Operations and Commandant of Marine Corps. These needs are generated by new weapon system developments, by modifications to existing weapon systems, and by fleet requirements for new training systems and capabilities to satisfy specific training tasks. Thus, the R&D program is balanced among improvements in highly specialized areas of simulation, training methods, training technology, and providing direct technical support to the training systems acquisition effort to reduce risk and cost.

The majority of the work undertaken constitutes the Technology Base Program and includes exploratory development (6.2), where feasibility and conceptual research plans are determined, and advanced development (6.3A), where proof-of-concept is established. Additional efforts include cooperative/collaborative research with other government agencies, non-profit institutions, and commercial firms. Research funds are received from the Office of the Chief of Naval Research, Naval Air Systems Command, Bureau of Naval Personnel, Naval Air Warfare Center, the Defense Logistics Agency, the Advanced Research Projects Agency, and the Army Research Institute.

NAVAIRWARCENTRASYSDIV has a long history of technology transfer to both the public and private sectors. NAVAIRWARCENTRASYSDIV is involved with the local school system, NASA Kennedy Space Center, and the Federal Aviation Administration to share information and expertise. There are currently eight Cooperative Research and Development Agreements (CRADA). CRADAs provide for the transfer of technology developed in federal government laboratories to the private sector. By sharing Navy training research, the public will benefit in having improved education and training. The Navy also receives valuable information in the exchange of information and resources.

The scientists and engineers in the Research and Engineering (R&E) Department at NAVAIRWARCENTRASYSDIV work closely together to promote transitions of promising technology and to resolve problems that occur in acquisition programs or with fielded trainers. The two R&E divisions that conduct the majority of the research are:

Advanced Simulation Concepts Division - Conducts R&D on improvements to the fidelity, cost and training effectiveness of image generation and display systems for training; researches, develops, and tests new concepts in low cost computer-based simulation; conducts R&D on multiplatform connectivity using DoD distributed interactive simulation network protocol; conducts R&D related to providing the physical stimuli that simulate the operational equipment; performs and directs computer applications research for warfare operations related training systems to improve training capabilities and cost effectiveness; and operates and maintains shop facilities to fabricate, repair or modify experimental mechanical and electro-mechanical devices for use in R&D projects.

Systems Integration Division - Develops and advances the basic knowledge required to provide the foundation for human factors applications to training systems; and conducts laboratory and field research to determine the degree to which new technology may be applied in the design of innovative training systems.

This brochure presents brief summaries of the FY94 research efforts at NAVAIRWARCENTRASYSDIV. Its purpose is to inform anyone who has an interest in training simulation technology of the research being performed at NAVAIRWARCENTRASYSDIV. For more information on the individual tasks, please call or write the principal investigator shown with each task. Copies of this brochure and summaries of each individual task are available from the Defense Technical Information Center (DTIC). The DTIC accession number is provided for each task that has a work unit summary on file. For information on obtaining copies from DTIC, call or write to:

Defense Technical Information Center
Office of User Services and Marketing
Bldg. 5, Cameron Station
Alexandria, VA 22304-6145
(202)274-6434/AUTOVON 284-6434

The brochure is organized as follows:

- Advanced Technology Development
- Exploratory Development
- Independent Research
- Joint Services R&D Program
- Small Business Innovative Research
- Tasks funded by other Navy activities
- Technology Transfer

ADVANCED TECHNOLOGY DEVELOPMENT - 6.3A
Program Manager - W. Parrish
Code PDR1   Phone: 407/380-8150

The objective of this program is to conduct proof-of-concept demonstrations, risk reduction developments, and cost-effectiveness investigations in simulator and training technology. It improves mission effectiveness and safety by applying knowledge about human learning to engineering design of training systems. This advanced development program is a continuing effort to improve fleet readiness through development, demonstration, and transition of simulation and training device technology to acquisition programs. In recent years, along with significant increases in the complexity of weapons systems, have come increasing requirements for more advanced simulation and training technology.

The program is based on requirements established by the Chief of Naval Operations (CNO). It is designed to improve the integration of technologies that support weapons and training system development, including all aspects of the research, development and acquisition process from technology development and demonstration, to systems requirements analysis, design, test and evaluation, and support for deployed systems. The program is organized around specific demonstration tasks that target critical technical risks that confront future weapons system acquisition programs. The demonstration tasks are carefully selected to focus attention on a problem and a solution, and to complement significant R&D investments made in the simulation industry.

The simulation and training devices program entails a balance between "technology push" and "requirements pull." The focus of the program is on demonstrations of technology for a wide variety of applications, from portable part-task trainers up to and including fullscale high-fidelity weapons system simulations, and battle-force combat simulations.

The advanced development efforts at NAVAIRWARCENTRASYSDIV are described on the following pages.

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FORWARD DEPLOYABLE AVIATION SIMULATOR TECHNOLOGY

Principal Investigator - W. Parrish
Code 25   Phone: 407/380-8150
DTIC Agency Accession Number: DN702028

BACKGROUND: Aircrews deployed on aircraft carriers lack a facility for recurrent training in critical flight skills and for conducting mission rehearsal exercises. These deployed aircrews must utilize operational aircraft to enhance and maintain skills since current training facilities are confined to large shore based installations. The use of operational aircraft is expensive, provides only limited training opportunities for advanced weapons procedures, and does not provide a significant mission rehearsal capability. The simulator industry does not have test beds to demonstrate integrated multisource components or to evaluate the training effectiveness of the advanced training hardware it develops. The Navy's aviation simulation test beds can demonstrate the feasibility of new design concepts and reduce the risk associated with integrating these concepts.

OBJECTIVE: The objective of this effort is to develop design guidelines for deployable aircrew trainers for critical flight tasks and mission rehearsal. This task will provide integrated demonstrations of key technology components which present risk areas critical to the success of transition to the Deployable Tactical Aircraft Training System (DTATS) planned for FY96. These areas include low cost reconfigurable cockpits and threat simulations for deployed applications, helmet mounted visual displays, simulator networking for interactive crew coordination, and cost effective photo-based image generators.

BENEFITS: Evaluation of advanced technology components will substantially reduce the cost and risk of acquiring DTATS. Furthermore, the hands-on experience provided to aircrews will greatly facilitate the refinement of the performance requirements for DTATS.

STATUS: The Tactical Environment Simulation has been installed and is operational through a Network Interface Unit. The computer system and hardware for the F/A-18 cockpit is up and running. A new and faster head-tracker has been procured and has been integrated with the helmet-mounted display and the image generator. Prediction algorithms for providing image stability with observer head motion have been installed and are being evaluated. Scaling and boresight procedures are being implemented. New databases have been formatted and added to the library.

The baseline configuration for the simulation was extensively evaluated by a F/A-18 pilot who is an instructor as well as an Operation Desert Storm veteran. The effects of haze and fog on the out-of-the-cockpit visual was implemented. Additional performance data has been obtained to drive the threat simulation.

The Tactical Situation Display has been improved and rehosted on a VAX screen eliminating the need for one CRT. The capability to use a PC based system for debriefing exercises conducted on the baseline configuration is being implemented.

MAJOR MILESTONES:

Topscene Integration	FY94
Enhance Sensor Displays	FY94
Enhance Avionics	FY94
Evaluation of Industry Components	FY94
Full System Demonstration and Evaluation	FY94
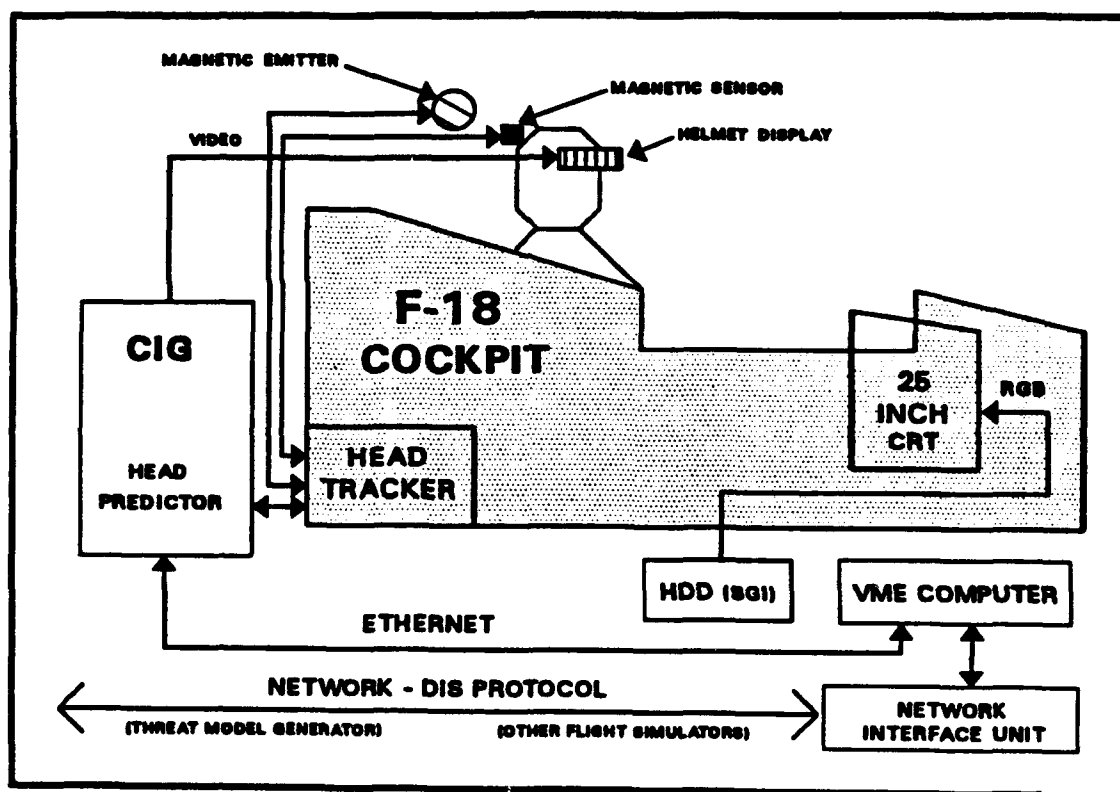
FORWARD-DEPLOYABLE AVIATION SIMULATION TECHNOLOGY (FAST)

NAVAL AVIATION SIMULATION NETWORK TRAINING
Principal Investigator - E. Williams
Code 25   Phone: 407/380-8443
DTIC Agency Accession Number: DN703022

BACKGROUND: There is a need to develop alternative technology for the development of a network architecture to interconnect Navy/Marine Corps aviation assets for various strike and combat air patrol mission training. Current network training technology is based on specialized part task trainers which simulate relatively slow moving entities in a two-dimensional plane. However, training systems for aviation devices simulate high velocity entities in three dimensions. As a result, compound problems such as data transmission delays, transmission medium bandwidth, entity dead reckoning, coordinate system conversion, and data encryption/decryption, will be encountered and must be resolved in order to implement a distributed interactive simulation (DIS) system for aviation devices.

OBJECTIVE: The objective is to demonstrate the networking of aviation training devices for tactical training. Results of this effort will provide affordable aviation training which will exercise all aviation components in a realistic networked environment including joint operations.

BENEFITS: This task will provide demonstrations of distributed simulation network technology advancements achieved. It will provide familiarity with a variety of potential threats; it will allow simulated operation over hostile terrain; it will employ all battlegroup forces; and it will provide practice in weapons employment and delivery in a realistic environment.

STATUS: A prototype Intelligent Gateway (IG) Network Interface Unit (NIU) is being developed in-house. The prototype IG NIU consists of an off-the-shelf VME platform which hosts in-house developed software incorporating the DIS functions for entity dead reckoning algorithms, coordinate conversion, protocol data unit (PDU) encoding/decoding, and PDU filtering. Currently, PDUs for Entity State, Collision, Fire, Detonation, Emitter, Signal, and Transmitter have been implemented.

A Cooperative Research and Development Agreement has been entered into with Motorola. Under this agreement, consultation services are available related to the IG NIU hardware/software platform and a generic aircraft front-seat simulation system is being developed. The generic front-seat simulator will be used for demonstration purposes with the prototype IG NIU at the upcoming Interservice/Industry Training Systems and Education Conference.

A contract with Grumman has been let for development of Technology Demonstrators for F14 aircraft back-seat functions. Deliveries are scheduled for Jan 94 and April 94. The Technology Demonstrators will be networked with the previously mentioned generic front-seat simulation to evaluate the IG NIU capabilities. Additionally, the Technology Demonstrators will be networked, using the NASNET IG NIU, with existing Grumman in-plant Laboratory systems and

with the WISSARD system when installed
at NAS Oceana.

MAJOR MILESTONES:

Develop prototype IG and Demo at I/ITSEC	FY94
Develop Technology Demonstrators and Demo with WISSARD	FY94
Network F14 Lab System to E2C Simulation System	FY95
Network F14D Trainer to DSI	FY95
Fullscale Demo of F14B Trainers to DSI	FY96
Network Tactical Aviation Trainers to BFTT	TBD

NAVAL AVIATION SIMULATION NETWORK TRAINING

NASNET
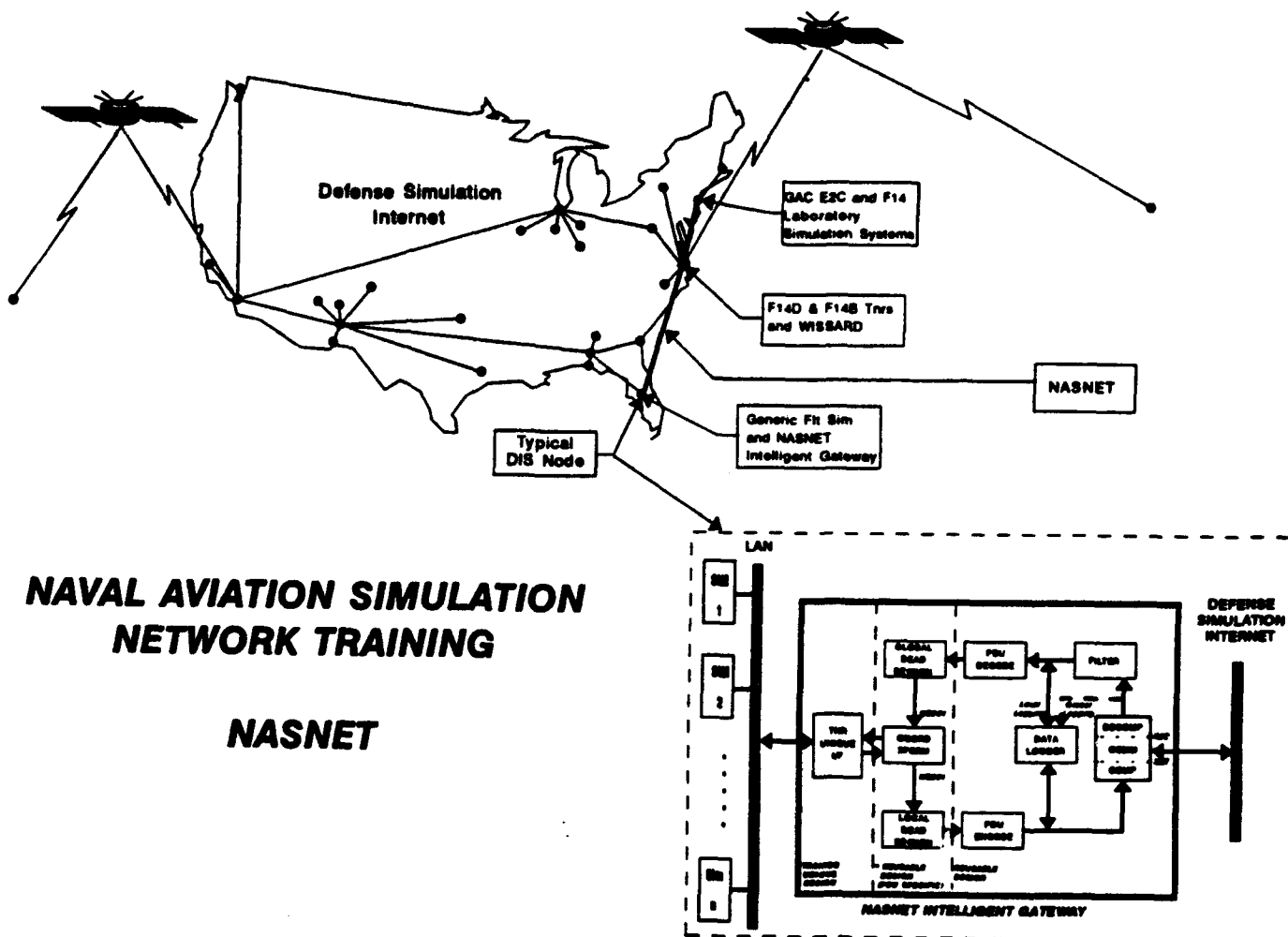
ORGANIC COMBAT SYSTEMS TRAINING TECHNOLOGY
Principal Investigator - R. Stratton
Code 25   Phone: 407/380-4587
DTIC Agency Accession Number: DN701012

BACKGROUND: Shorebased training systems for shipboard combat systems have become prohibitively complex and expensive, and do not contribute to readiness to a degree sufficient to warrant their cost. To reduce training costs and increase readiness, the Navy has established the Afloat Training Organization (ATO). In the future, tactical training which was formerly conducted at shorebased sites, will be done aboard ship under the control of the ATO.

This is a major change to the training continuum and makes the ship the cornerstone for combat systems, damage control, and hull, mechanical and engineering training. For combat systems training, this new approach will require all major combatants to be equipped with a combat system embedded training capability. The embedded training capability will have to accommodate multi-warfare as well as multi-ship training. Because of the large number of ships involved, the per ship cost for the embedded training capability will have to be kept low for the new strategy to be affordable.

The Navy has established the Battle Force Tactical Trainer, or BFTT Program, to support the ATO mission and to meet future combat systems training needs. The program is administered by NAVSEA 06K2. Naval Surface Warfare Center provides technical management and direction. The BFTT is scheduled to become operational in the mid and late 1990's.

OBJECTIVE: The overall objective of this effort is to develop technology that will reduce the costs associated with shipboard embedded training systems, demonstrate the technology, and transition the research products to programs which support the ATO mission such as BFTT. "Cost" in this context refers not only to direct dollar cost for acquisition, but also to indirect costs such as logistics, operational and manpower costs, and other costs not as visible as acquisition costs.

BENEFITS: This task will develop low cost combat systems embedded training technology that will support the Navy's new approach to training. The products will be in the areas of scenario generation and control, combat system simulation and stimulation, performance measurement and feedback, and multi-ship connectivity using the DoD Distributed Interactive Simulation (DIS) network protocol.

STATUS: The approach chosen to develop the low cost technology was to select an existing Navy training system that had most of the required capabilities, redesign and repackage it using modern off-the-shelf technology, and in the process drastically reduce physical size and cost. The training system selected for downsizing was the Pierside Combat System Team Trainer (Device 20B5) for the FFG-7 Class Frigate. The 20B5 software is being rehosted from Gould 3287 to non-proprietary Motorola 88000 micro-computers. Hardware and software redesign of the Device 20B5 Instructor/Operator Station using X

Terminals was completed in FY92. Integration of the rehosted 20B5 simulation system with the FFG-7 Combat Direction System is underway. A capability to process messages using DIS protocol has been developed and integrated into the simulation system.

MAJOR MILESTONES:

Single Ship Multi-warfare Embedded Training (Lab Demo)	FY94
Demonstrate DIS Protocol Implementation (Continuing effort until DIS fully operational)	FY93/FY94
Shipboard Electronic Warfare Capability using DIS Protocol	FY94
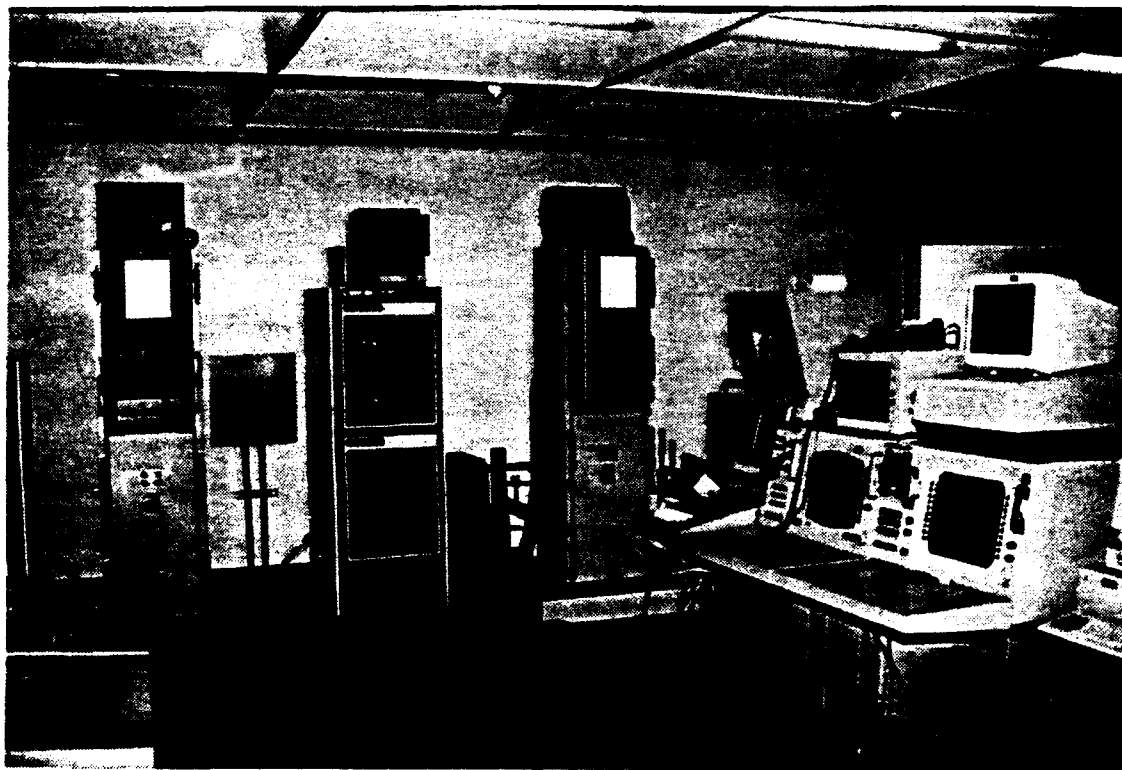
Combat Information Center Mockup

ADVANCED TECHNOLOGY SONAR EMPLOYMENT TRAINING

Principal Investigator - C. Matthews
Code 25   Phone: 407/380-4796
DTIC Agency Accession Number: DN703023

BACKGROUND: Current submarine combat/SONAR system training does not provide effective employment training, with only 30% of the AN/BQQ-5 SONAR system capabilities being utilized. Simulation and instructional technologies do not stress the skills and knowledge to fully understand and utilize system capabilities. Onboard training capabilities are not adequate to maintain proficiency and were not designed as part of the tactical system. Additional simulated instructional features are required to support self-paced training and to off-load current instructor tasks.

OBJECTIVE: The objective is to develop simulation and instructional technologies to stress the skills and knowledge to fully understand and utilize AN/BQQ-5 SONAR system capabilities.

BENEFITS: Concept visualization aids will be developed to facilitate the learning of key operational concepts which are difficult to teach using current training system paradigms. A wider range of controlled experience can be presented in the context of training exercises so less reliance on uncontrolled on-the-job opportunities will be required; more uniform training will result, with less variance in skill and knowledge levels among SONAR operators.

STATUS: An analysis of the SONAR technician curriculum has defined a set of eight difficult-to-learn concepts. Functional analysis of the tactical equipment has resulted in a non-real-time modeling approach using commercial equipment.

MAJOR MILESTONES:

Develop Initial Instructional Displays	FY94
Demonstrate SONAR Models	FY94
Demonstrate Simulation Sub-system	FY95
Demonstrate Instructional Sub-system	FY95
Demonstrate Integrated System	FY96

ADVANCED TECHNOLOGY SONAR EMPLOYMENT TRAINING
CONCEPT VISUALIZATION AIDS
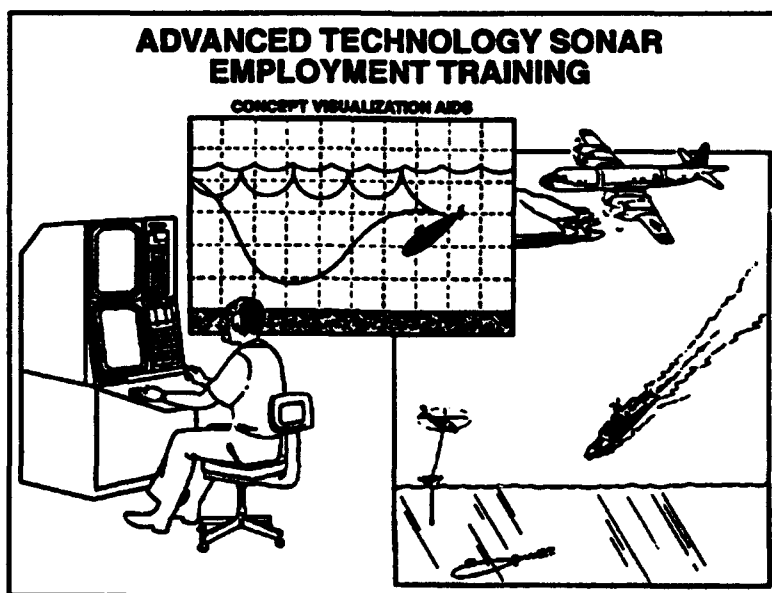
SHIPBOARD INSTRUCTOR TRAINING AND SUPPORT

Principal Investigator - J. Cannon-Bowers
Code 26   Phone: 407/380-4830
DTIC Agency Accession Number: TDB

BACKGROUND: Advances in Navy weapon system complexity and changes in expected conflict scenarios have significantly increased the demand on human operators. Modern battle management systems require operators to receive, process, and combine unprecedented amounts of data in time compressed situations, where both inter- and intra-ship team coordination are required. Moreover, a host of stressors exists in the combat environment that mitigate against successful tactical performance. Coupled with current fiscal constraints, these factors dictate that tactical training systems evolve so that they impart crucial team combat skills in the most effective and efficient manner possible. Recent advancements in training system technology are fostering the development of embedded or on-board training systems to help meet this training challenge. One of the main problems with existing on-board training systems is a lack of support or training for instructors. What is needed, therefore, is a deployable mechanism to provide training for individuals who are responsible to train combat systems teams, and to support crucial instructor functions at sea.

OBJECTIVE: Objectives are to develop technology to provide a mechanism for on-line performance recording and analysis to support the measurement and diagnosis of performance in combat teams; to establish criteria for individuals and teams engaging in complex tactical decision making; and to develop methods to select and design appropriate training scenarios.

BENEFITS: This effort will result in higher quality training using shipboard systems via enhanced instructor preparation and support. The instructor support features will greatly improve the ability of shipboard instructors to conduct training, provide performance feedback, and ensure optimal team performance.

STATUS: This is a proposed FY94 new task.

MAJOR MILESTONES: Milestones will be based on approved final funding.

HELMET MOUNTED MISSION REHEARSAL SIMULATION SYSTEM
Principal Investigator - W. Parrish
Code 25   Phone: 407/380-8150
DTIC Agency Accession Number: DN703042

BACKGROUND: The continual introduction of sophisticated military equipment into the arsenals of third world countries will ensure that future threats arrayed against naval aviation will be of the most advanced technology. Naval aviation's use of increasingly complex aircraft, sensors, weapons and tactics against skillful adversaries in widely diverse scenarios increases the need for creative training techniques to assure mission success. Due to a deficiency of training ranges, weapons and real world training constraints, weapon systems training is rarely available to carriers and forward deployed units. Additionally, accomplishments with mission-preview systems during Operation Desert Storm suggest mission rehearsal will substantially improve the probability of "first pass" mission success. To sustain vital combat skills while deployed and to increase the probability of first pass mission success, simulated weapons employment training and air strike mission rehearsal must be continuously accessible to carrier and forward deployed aircrews.

OBJECTIVE: The objective of this Advanced Technology Demonstration is to provide proof of principle of helmet-mounted display (HMD) systems as part of a tactical aircraft weapon system simulation capable of deployment aboard a carrier for mission rehearsal of night and day strike missions. The program deals with critical high risk technologies needed to respond to the current deficiency of adequate complex weapon practice and mission rehearsal during deployment. The task is designed to transition directly to the Navy Deployable TACAIR Training System (DTATS) in FY96.

BENEFITS: Evaluation of advanced technology components will substantially reduce the cost and risk of acquiring DTATS. Furthermore, the hands-on experience provided to aircrews will greatly facilitate the refinement of the performance requirements for DTATS.

STATUS: Successful demonstrations have been made depicting real time, three dimensional, non-programmed, out-the-window views of the real world using photo-imagery derived from satellite and other photographic inputs. This imagery has been correlated with flight dynamics to faithfully simulate an aircraft flying over terrain. The image has been incorporated into a helmet display demonstrating an unlimited field of regard. Other sensor displays, such as FLIR and RADAR, have been demonstrated using the same database as the visual display. A contract has been awarded to acquire wider fields of view and color for the helmet.

MAJOR MILESTONES:
HMD Development

Initial HMD	FY93
Final HMD	FY94/FY95
Evaluations	FY93/FY94/FY95

Photo Imagery

Image Enhancement	FY93/FY94
Dynamic Stability	FY94
Sensor Compatibility	FY95
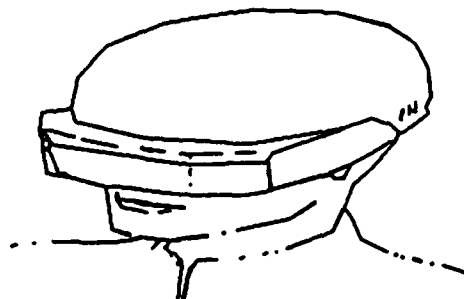
The objective of this program is to provide mission support technologies essential for all naval operations through the development of training device simulation technology. The Office of Naval Research mission area for training systems is concerned with improving the training effectiveness of Navy training devices, lowering their costs, and extending training device applicability into more training domains. The technology being developed will enhance visual and sensor simulation capabilities, provide advanced computer hardware and software concepts for greater real-time simulation capabilities, improve the instructional value of simulation systems, and define the necessary functional characteristics of training devices.

NAVAIRWARCENTRASYSDIV has four exploratory development projects. Two projects, Instructional Technology and Simulation Technology, are divided into discreet tasks. The individual tasks and the remaining two projects (Virtual Environment Training Technology and Tactical Decision Making Under Stress) are described on the following pages.

AIRCREW COORDINATION AND PERFORMANCE
Principal Investigator - C. Prince
Code 26   Phone: 407/380-4831
DTIC Agency Accession Number: DN709006

BACKGROUND: The coordinated performance of aircrews for mission safety and success has become an issue of concern for military training. Research has shown problems stemming from insufficient skills in effective management of cockpit resources. Accident and incident investigation has revealed that 60-80 percent of all accidents are caused by problems with decision making, leadership, judgment, communication and crew coordination. Improved training of aircrews in task coordination is necessary for crew performance effectiveness, air combat maneuvering, and operational readiness. Current aircrew training emphasizes specific, necessary skills and is not designed to provide experience with crew coordination. This research effort will identify crew coordination factors that lead to effective performance, as well as the factors that contribute to a failure of coordination. Emphasis will also be placed on the need for standardized, objective, and relevant aircrew performance measurement as a natural corollary to the aircrew training issue.

OBJECTIVE: Objectives of this task are to define and assess aircrew coordination skills, develop performance measures indicative of crew performance, and develop technology to support training.

BENEFITS: This effort will provide: (a) a framework to guide and focus Navy aircrew coordination training research; (b) determination of instructional technology relevant to aircrew coordination training; (c) procedures and tools to assess and measure crew coordination; and (d)

methods for performance assessment and evaluation in aircrew coordination training. These products will transition to the 6.3 Aircrew Coordination task, which is developing and validating proof-of-concept aircrew coordination training modules. Aircrew training is costly, but is not nearly so expensive as an absence of training or training that is inefficient. This task can introduce greater efficiency into the aircrew coordination performance area by determining: 1) the requirements of coordinated performance; 2) the obstacles to that performance that arise both from human factor design deficiencies and training needs; 3) diagnostic measures to determine specific training needs; 4) training methods that are designed to address specific problems; and 5) performance measures for aircrew coordination. The results can directly impact all multi-seat operational systems.

STATUS: Fifty crews of aviators, flying in two-person crews, participated in research using realistic scenarios and a measurement instrument for providing feedback. Results of the experiment showed that student aviators were able to improve their team process behaviors from the first scenario to the second scenario if they received feedback on their team process performance from their instructor. Timing of the feedback was not found to be important. Decision making strategies for a separate set of aviators who flew two scenarios that included three distinctly different decision types were found to differ between experts and novices. Novices tended to use the same strategy, no matter what decision requirements they

faced, and experts were more flexible in their employment of strategies. A new experiment is planned for FY94 to extend the knowledge about scenario development for specific training purposes, the effects of feedback on team process skills and to further refine the measurement tools that have been developed for team process.

MAJOR MILESTONES:

Development and Testing of Team Process Measurement	FY91
Employment of Measurement for Feedback	FY92
Research on Measure of Decision Making Strategies	FY93
Refinement of Measurement Instrument	FY94
Measure of Process in Advanced Technology Aircraft	FY95
Transition to Fleet	FY96
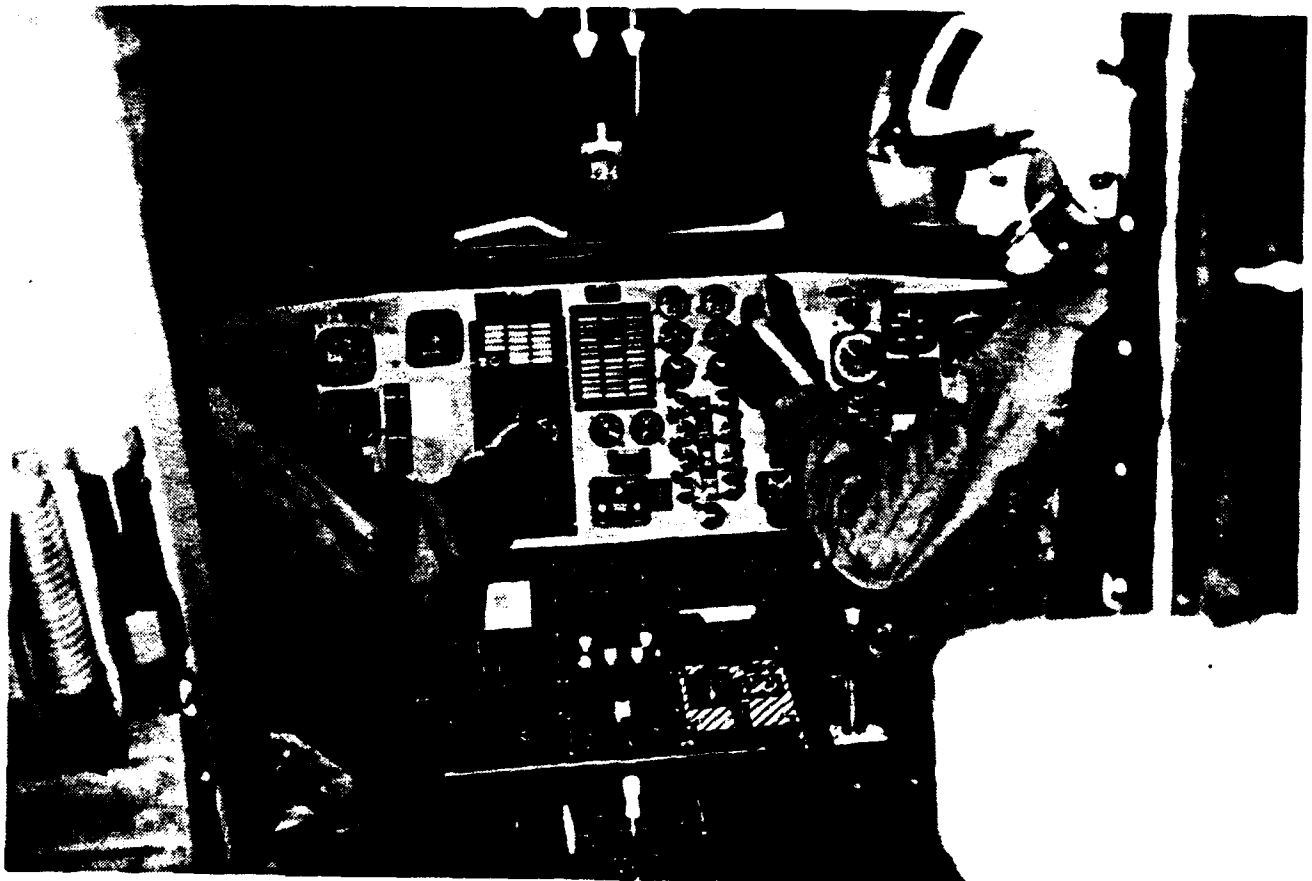
RETENTION OF TRAINED SKILLS
Principal Investigator: K. Ricci
Code 26   Phone: 407/380-4661
DTIC Agency Accession Number: DN702025

BACKGROUND: Even the most effective training program cannot ensure that trainees will be able to perform on the job if they do not retain the skills they have learned. This is especially problematic for perishable skills such as complex procedural tasks, tasks that are seldom practiced, or for reservists, who only train during brief and intermittent periods. Although considerable research has been conducted on skill retention, most training effectiveness evaluations are not able to longitudinally track trainees to determine how long and how well skills are retained after training. Additional information is needed on the effects of task parameters, amount and distribution of practice, use of training devices and simulators, instructional techniques, conditions of transfer, individual differences, and other variables on skill retention. Information is also needed to develop performance measures that can be used to predict operational performance.

OBJECTIVE: To develop guidance for improved training device and training simulator design, more effective and efficient methods for use of these devices, and ways to improve performance measurement methods for use in predicting operational performance and to improve skill retention.

BENEFITS: Information on the variables affecting skill retention will help in the development of training devices, simulators, and instructional techniques, which can efficiently maximize the retention of critical skills. Such information, together with predictive performance measures, will also enable the Navy to target personnel who need refresher training to maintain criterion levels of operational readiness and will

provide information on the design of refresher training. This retention of skills has been identified as a serious problem in the Navy and DoD. However, there is currently a limited knowledge about the retention of skills.

STATUS: Following a review of the skill retention literature, two areas have been identified for further research: complex cognitive skills and team skills. Experimental facilities have been established to study these skills. Work will begin in FY94 to develop a research methodology to study the benefits of above real-time training as it relates to improved skill retention.
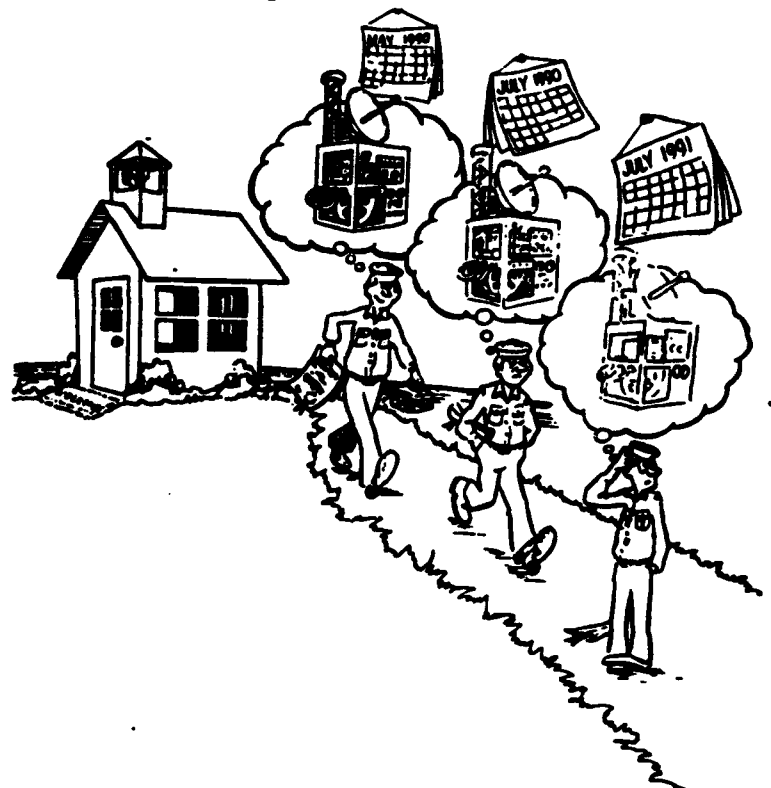
MAJOR MILESTONES:

Establish Facility	FY92
Conduct Experiments	FY93
Technical Report	FY94

EMBEDDED TRAINING TECHNOLOGY
IDENTIFICATION AND DEVELOPMENT
Principal Investigator: R. Ahlers
Code 26   Phone: 407/380-8569
DTIC Agency Accession Number: DN708021

BACKGROUND: Initial approaches to embedded training (ET) have focused on the problems associated with stimulating a wide variety of weapon system sensors to create realistic training. This engineering concern must be complemented with research on how to best utilize shipboard systems for effective training. There will be few experienced shipboard training personnel to control the many simulated hostile platforms, to observe and evaluate the performance of the trainees, to provide motivation and diagnostic information to the trainees, to modify the training program to meet unexpected circumstances, or to manage the training program in order to assure long term improvement and progress.

OBJECTIVE: There are two objectives: 1) develop, demonstrate, transition, and document instructional support features such as student feedback displays, scenario authoring, tactical target control, and curriculum structuring; and 2) provide empirically-based guidelines for instructor interface design so that the instructional support features will be easily accessible.

BENEFITS: Instructional features, implemented in software, will augment the limited shipboard instructor resources. Reduced numbers of training support personnel dictate that the operation of these instructional features be easily learned and efficiently accessed. A current survey found that 25 percent of instructors were still learning about their shorebased training systems after four months of on-the-job training. This situation is likely to be more severe with the Navy ET systems where personnel do not have the primary function of training. Fielding shipboard training systems which are more easily approachable will lead to increased usage.

STATUS: A technique for cognitively engineering the instructional content of tactical console ET lessons was evaluated at the Aegis Training Center. Results were positive in supporting the value of the cognitive engineering approach. An effort to integrate the roles of ET with decision aiding has entered a second phase. The integration methodology was implemented as a software tool to test the robustness of the methodology. The use of ET in instructor/operator consoles to support the operation of the training system is being investigated. Preliminary designs for on-line help are to be evaluated using instructor tasks and training system prototypes developed in-house. Alternate display formats for presenting feedback on trainee performance have been developed and evaluated.

MAJOR MILESTONES:

Demonstration, Intelligent Platform Modeling System	FY93
Technical Report, Transitioning Cognitive Lesson Engineering to AEGIS CAST	FY94
Technical Report, Design Tool for Integrated Decision Aiding/Embedded Training	FY94
Experiment, Design of On-Line Assistance for IOS	FY94

EMBEDDED TRAINING TECHNOLOGY

L-TRAN CONSOLE

INSTRUCTIONAL PROCESSES FOR SITUATION AWARENESS
Principal Investigator - C. Prince
Code 26   Phone: 407/380-4831
DTIC Agency Accession Number: DN703010

BACKGROUND: Situation awareness has been identified as a critical construct in aviation performance and is likely to be a critical variable in other settings. Despite its importance, situation awareness, particularly situation awareness of the entire crew, is a concept that has not been developed in terms of the theoretical underpinnings that contribute to this construct. This lack of research has limited the extent to which instructional strategies and performance measurement tools can be developed to further investigate the situation awareness construct.

OBJECTIVE: To conduct situation awareness research to identify the critical underlying individual and team components, develop instructional strategies, and develop performance measurement tools.

BENEFITS: Research on the variables underlying situation awareness will help in the development of effective instructional strategies for training both individual and team-level situation awareness, as well as impact the proficiency of performing other team and individual level skills. This effort will also result in effective performance measures for training feedback and performance criterion development. Information from this research will have a direct impact on human performance research, in general, as well as have implications for a number of variables in cognitive psychology, such as self-monitoring behaviors.

STATUS: Existing literature on situation awareness and relevant areas of cognitive psychology were surveyed, resulting in a documented literature review. In addition, critical individual and team-level situation awareness behaviors are being identified along with appropriate instructional strategies for training these behaviors. This information is being embedded in a theoretical framework of the situation awareness construct to guide the research. A testbed community has been identified and experimental hypotheses are being generated.

MAJOR MILESTONES:

Phase I - Generate Theoretical Framework	FY93
Phase II - Develop Measures	FY94
Phase II - Conduct Experiments	FY94
Phase III - Provide Guidelines	FY95

UNDERSTANDING SITUATIONAL AWARENESS
INTERIOR AND EXTERIOR ENVIRONMENTS
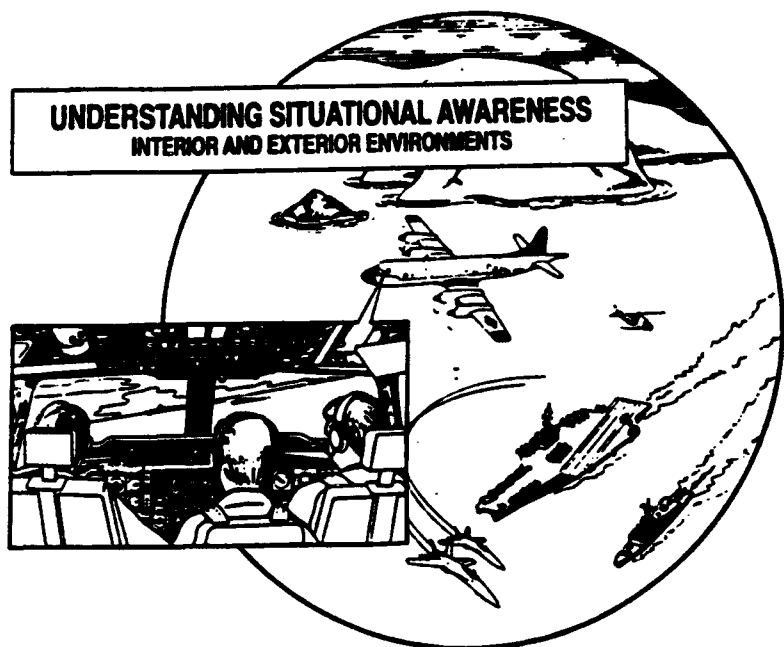
TRAINING TECHNOLOGY FOR DISTRIBUTED SYSTEMS
Principal Investigator - R. Willis
Code 26   Phone: 407/380-4825
DTIC Agency Accession Number: DN703011

BACKGROUND: There is a growing movement in the surface community to deliver combat systems training on board ship rather than in shore-based facilities. Afloat Training Organizations (ATOs), newly formed to support this movement, will rely almost exclusively on ship-board training for combat systems teams (both pier-side and at sea). These organizations will emphasize coordinated multi-warfare, battle force level training scenarios. To accomplish this training, ships, the teams that train on them, and instructional support personnel must be networked to form a distributed training system. This shift in training delivery will require evaluation of current training strategies and supporting systems.

OBJECTIVE: Objectives are to investigate the types of training techniques required to support distributed teams, develop technologies to support performance assessment and feedback in distributed teams, and develop design guidelines to provide instructional support in distributed training.

BENEFITS: This effort will provide instructional guidelines, principles, and recommendations for employing battle force level exercises associated with distributed simulation, such as the Battle Force Tactical Training System and the Tactical Combat Training System, and for support of ATOs. Information about instructional factors impacting distributed systems and ATOs, along with behavioral skills and performance measures, will allow simulated exercises to be transformed into efficient ship-based

training within the context of composite warfare command doctrine. It also will add valuable technology applicable to all training environments on shore and at sea.

STATUS: A research plan was generated which identifies training factors which have the potential to affect training delivery in distributed systems. The research plan outlines testable hypotheses in the areas of performance assessment and performance feedback. In addition, the requirements for a research facility to examine performance and feedback within a distributed environment are being documented. Research has been conducted to identify performance differences between distributed and non-distributed systems. Results suggest team processes are impacted within a distributed system.

MAJOR MILESTONES:

Develop Research Plan	FY93
Establish Research Facility	FY93
Conduct Experiments	FY93-96

TCTS OPERATIONAL PERFORMANCE REQUIREMENTS OVERVIEW

- SUPPORT TRAINING IN ALL WARFARE AREAS
- INDIVIDUAL OR COMBINED EXERCISES
- REALISTIC COMBAT ENVIRONMENT
- ANY COMBINATION OF TRAINING PARTICIPANTS
  - LAND, AIR, SEA, UNDERSEA
- ANY GEOGRAPHICAL AREA-WORLDWIDE
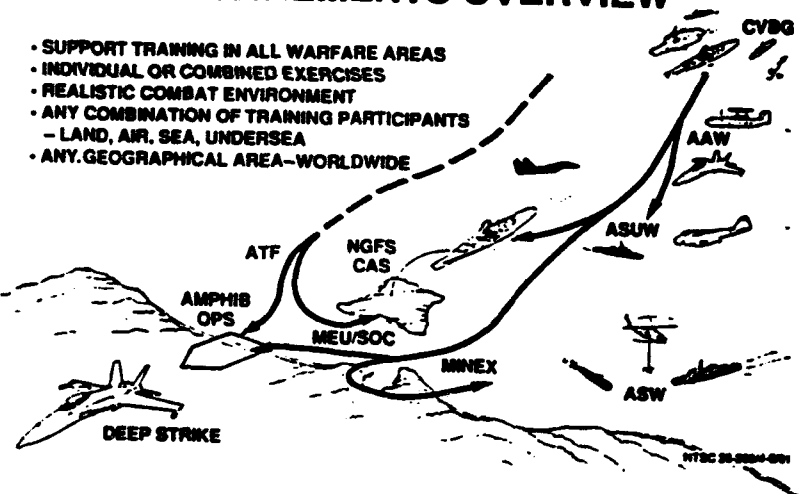
SUBMARINE EMPLOYMENT TRAINING
Principal Investigator - R. Ahlers
Code 26   Phone: 407/380-8569
DTIC Agency Accession Number: DN703012

BACKGROUND: On-the-job experience continues to be relied upon to integrate basic skills learned in Navy schools. This experience is typically unguided, differs unsystematically for each individual, and often does not lead to satisfactory job performance. Formal operator training focuses on how to operate complex equipment but does not impart a knowledge of the purpose of various features and operational modes. Employment training (training in the effective employment of system capabilities) should fill the gap between formal operator training ("knobs and dials") and tactical team training, either at-sea or in a training simulator. The technologies used to support the two types of training have proven difficult to integrate, and many difficult issues must be resolved before an effective employment trainer can be designed.

OBJECTIVE: The objective is to develop and evaluate training techniques which will facilitate the development of an understanding for equipment operation. An emphasis will be placed on providing a student with a set of tools which will allow the exploration of a simulation environment. Two testbeds will be used: a periscope skills trainer for analyzing simpler skills and a networked part-task tactics trainer for investigating more complex cognitive skills.

BENEFITS: The technology developed in this task will be widely applicable to various training domains. Operators will better understand their equipment, and consequently team training will be more

effective. Shipboard training, where little instructor assistance is available, is a good candidate for the technology because of its increased focus on embedded instructional features. The current reliance on shore-based team training systems utilizing expensive tactical equipment will be significantly reduced.

STATUS: An initial periscope skills training testbed was completed and instructional support features are being developed. Initial evaluation experiments at the Naval Submarine School, New London, will begin.

MAJOR MILESTONES:

Demonstration, Periscope Skills Trainer	FY93
Evaluation, Instructional Paradigms	FY94
Demonstration, Networked Part-Task Tactics Training Testbed	FY94
Evaluation, On-Line Student Tools	FY96
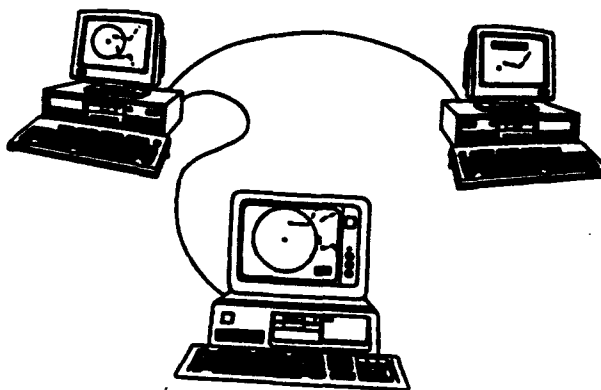
SIMULATION OF ADVANCED SENSORS
Principal Investigator - J. Allen
Code 26   Phone: 407/380-4579

BACKGROUND: The expansion of Navy and Marine Corps roles into littoral night operations has increased the use of night vision devices (NVD) in low-altitude flight missions and certain areas of shipboard operation. The hazards associated with increased night operations emphasize the need for NVD equipment simulation and training. From night to night and hour to hour the appearance of targets and terrain change significantly. Safe effective use of NVD equipment such as night vision goggles (NVGs) requires that operators be aware of, and trained to, recognize night illumination characteristics. Operators also need to understand and respect current equipment capabilities and limitations. Training systems which correctly simulate these characteristics and the multitude of environmental conditions have yet to be developed.

OBJECTIVE: The primary objective is to design, demonstrate and evaluate a low-cost NVG training feasibility model which can illustrate how diverse nighttime environments (time of night, moon angle/phase, clouds, fog, sea state, lights, flares etc) affect NVG use during littoral night missions.

BENEFITS: Payoffs for a fully successful task include: demonstration and evaluation of a low-cost computer based NVG training product which enhances night operations training; a specific night mission training needs analysis providing mission specific training objectives; empirical data and lessons learned to guide night simulation and modeling for night vision device simulation or stimulation; a first look analysis of a pair of simulated NVGs.

STATUS: We are continuing to gather NVG imagery, reports and other material from Navy, Marine, Army and Air Force sources. We have specified a portable computer aided measuring system to determine and document nighttime spectral profiles under various
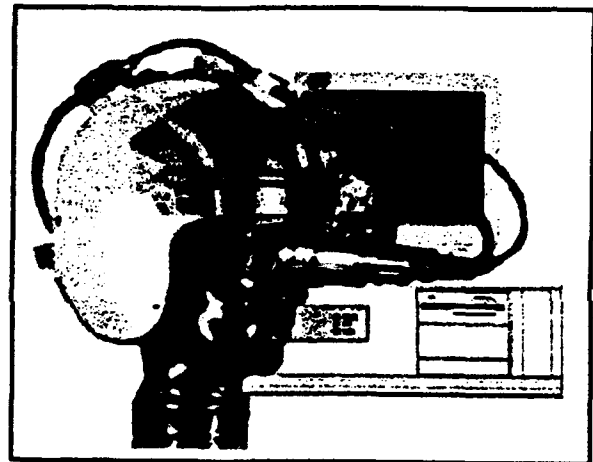
NVG Training Feasibility Model

environmental conditions. An NVG monocular is being used to gather the accompanying visual data. A preliminary laboratory test bed has been developed to aid in the initial image processing and data gathering stage.

MAJOR MILESTONES:

Training Needs Analysis	FY94
Complete Test Bed	FY95
Progress & Final Reports	FY94/95/96

ACTIVE SONAR SIMULATION FOR TRAINING
Principal Investigator - L. Healy
Code 25 Phone 407/380-4590
DTIC Agency Accession Number: DN700011

BACKGROUND: The Navy has an urgent need for on-board operator training in the use of low-frequency active (LFA) SONAR for identification and tracking of submarine targets. The change in the military threat from global conflict to regional conflict and from nuclear submarines operating in the deep ocean to diesel submarines operating in shallow water puts added emphasis on the use of active SONAR. Training in the use of LFA SONAR requires (1) means to provide a realistic representation of the operator displays, and (2) training methods that teach the operator to relate the operator displays to the physical situation.

The key element in providing operator training is the generation of realistic displays that provide appropriate representation of the submarine maneuvers in the shallow ocean environment. The displays must then be related to the maneuvers and the ocean characteristics to provide the student with an understanding of the relationship.

OBJECTIVE: The objective of this task is to synthesize the high-fidelity LFA displays necessary for training and to incorporate these displays and to demonstrate these displays in interactive courseware for on-board operator training.

BENEFITS: Benefits derived from this research include: (1) significant improvement in the training of LFA SONAR operators and their ability to interpret the acoustic displays, (2) ability to use standard Navy desktop computers to provide ASW operator training, and (3)

techniques and data bases which can be incorporated into larger and more complex training systems.

The near term results of this research effort will contribute to the introduction of LFA SONAR into the undersea surveillance community. The immediate use this research will be development of a course for on-board training of acoustic operators at Integrated Undersea Surveillance System (IUSS) sites. The results will provide realistic scenarios incorporated in tabletop trainers using personal computers, thereby allowing students to observe the change in the ASW display as a result of operator actions. The methods and techniques will apply equally to training aboard ship both underway while deployed and while in home port.

STATUS: A definition of the instructional system to be used in generating active SONAR instruction has been developed. The statement of work for contractor development of mathematical models to create the LFA displays has been completed.

MAJOR MILESTONES:

Basic Lesson for Baseline ICW	FY94
LFA Operator Display Modeling Report	FY95
Baseline Interactive Courseware Report	FY96
Courseware Using LFA Modeling	FY96
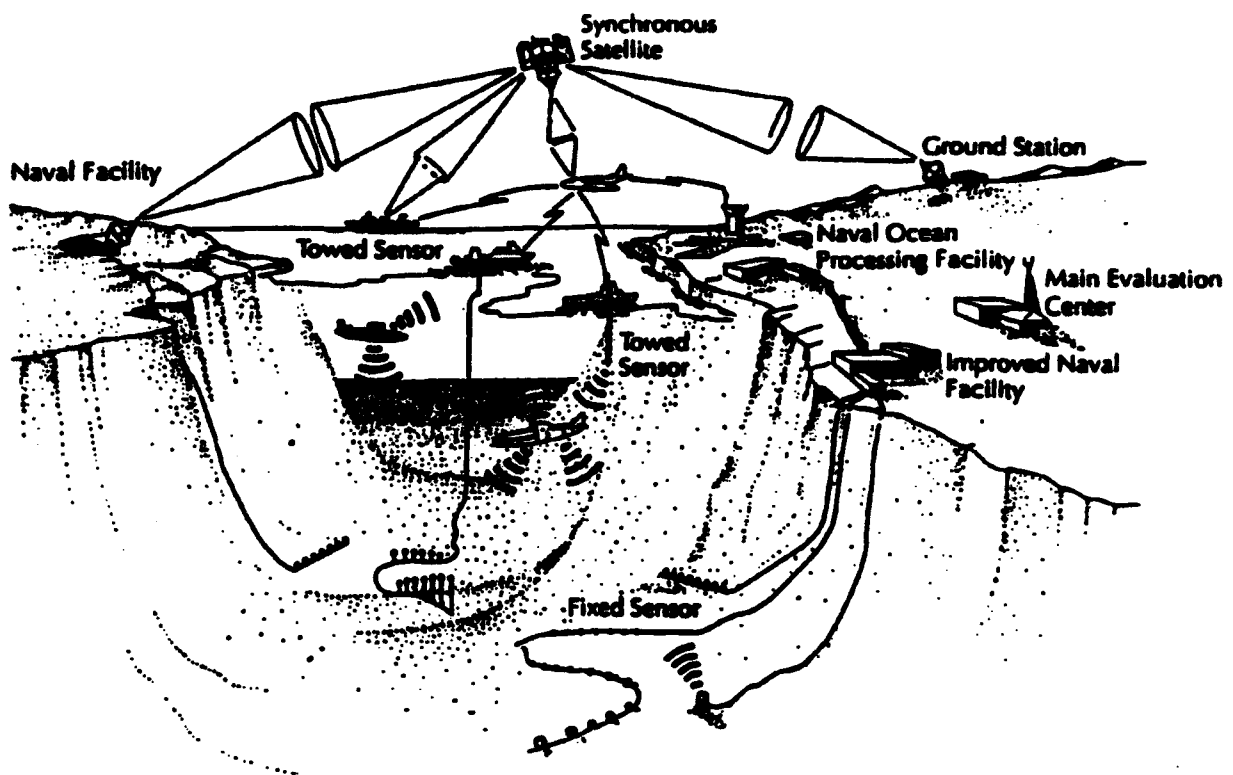
ACTIVE SONAR MODELING

MOVING WEAPONS 3-D SIMULATION
Principal Investigator - A. Marshall
Code 25   Phone: 407/380-4653
DTIC Agency Accession Number: DN702026

BACKGROUND: Technology currently available to provide realistic 3-D simulator environments for shoot-no-shoot training and also allow machine gun training from moving vehicles and aircraft without live rounds or firing ranges is insufficient. The technical problems are: development of a 3-D video system, development of a low-cost miniature motion platform to support the gunner and the weapon; development of the equations of motion; development of a means of simulating tracers and explosions in 3-D.

OBJECTIVE: Research the efficacy of the use of 3-D TV in various weapons trainers.

BENEFITS: This technology will initially be used to develop devices to teach gunners to fire small arms in shoot no-shoot environments. A 3-D/Stereo Weapons Trainer is being investigated because it is anticipated it will add a sense of reality, immerse the trainee deeper into the training scenario, and induce more realistic stress. The program will also investigate firing machine guns from the following moving platforms: Riverine Water Craft Humvee, Dune Buggies, etc., and Helicopter Door Gunnery Trainers. The trainers will reduce the use of real vehicles which will save money on fuel and wear and tear on helicopters and land vehicles. Special firing ranges will no longer be required. In many locations and countries the firing of live machine gun rounds is not permitted. The trainers will be able to more accurately score and determine why a trainee is missing the target.

STATUS: A 3-D large screen display for small arms and minor caliber weapons has been designed and the prototype will be displayed at the I/ITSEC 93 conference. The system provides interactive stereoscopic images of the environment and targets that virtually leap from a 100 inch diagonal video projection screen. The system uses switched LCD glasses, worn by the trainee, to convert video recorded from two separated video cameras and stored on video disk to 3-D like images. Three-Dimensional computer graphics objects are added to provide graphics feed-back, portray tracers, and increase the realism of simulated aggressors. The prototype has been tested and the efficacy of the prototype will be reported. The use of a small motion platform with the system will be investigated. A technical paper, "Application of A Three-Dimensional Display for Weapons Training" will be presented at I/ITSEC 93.

MAJOR MILESTONES:

Fabricate Research Model	FY93
3-D Effects Study	FY93
Motion Base Research,	FY94
Efficacy Testing, Report	

LCD GLASSES AND SIMULATED WEAPON

TACTICAL TRAINING INSTRUCTOR COMPONENTS (TACTICS)
Principal Investigator - B. Pemberton
Code 25   Phone: 407/380-4602
DTIC Agency Accession Number: DN700009

BACKGROUND: New concepts are required to effectively deal with a ten-fold increase in the number of platforms simulated in tactical training systems. Prior to 1990, a 200 platform tactical scenario required from 6 weeks to several months to prepare. In the 1990s, the total number of platforms simulated is currently 2000 (e.g., Tactical Combat Training System (TCTS)). In the future, joint distributed interactive simulation (DIS) networked training exercises will raise the number of platforms simulated by another factor of 10 to 100. This task is investigating two new concepts to meet the increasing demand on tactical training system instructors: 1) automatic scenario generation (ASG) to reduce scenario preparation time; and 2) automatic scenario control (ASC) to reduce the instructor workload.

OBJECTIVE: The objective is to investigate the two concepts and develop two demonstration systems, ASG and ASC. The ASG objectives are to reduce instructor's time and effort for scenario setup, and make the user-machine interface easy to use. The objectives of the ASC are to reduce instructor workload, allow the instructor to monitor more information, and provide real-time performance measurement and feedback. Both concepts will be DIS compatible.

BENEFITS: Fleet readiness and mission effectiveness will be enhanced with the automation of the instructor training system functions. Results of this research will provide rapid development and operation of training system exercises that are representative of operational events. The time required to create a typical scenario will be reduced from weeks to hours. The amount of information required to specify a scenario will be reduced by over 90%. During control of scenarios, instructors will be provided multiple windows to increase the amount of information monitored, automatic warfare advisors to increase instructor response to rapidly changing tactical situations, and automatic performance measurement and feedback to provide timely evaluations of exercise successes.

STATUS: Developed initial prototype ASG utilizing expert system technology, windowing technology on a workstation, naval warfare publications, and interviews with fleet experts. Developed initial specification for joint DIS capable ASG prototype.

MAJOR MILESTONES:

Demonstration ASG prototype called Automatic Training Exercise Force Lay-down Decision Aid for Embedded Training (TEFL)	FY93
Demonstrate ASG and DIS capability at I/ITSEC	FY94
Demonstrate ASG with in-house embedded training facility	FY94
Demonstrate ASG with BFTT	FY95
Coordinate ASG and ASC with Naval Warfare Assessment Warfare Center display and debrief tools	FY95

TACTICAL TRAINING INSTRUCTOR COMPONENTS (TACTICS)

TACTICS TOOLS (ASG & ASC)

Automated Exercise Preparation, Editing, Preview, & Monitoring

DIS PACKETS

Man-in-the-loop Training Simulators

Distributed Interactive Simulation (DIS) for Joint Training Systems

Wargaming Simulators

Instrumented Ranges

Operationally Embedded Training Systems
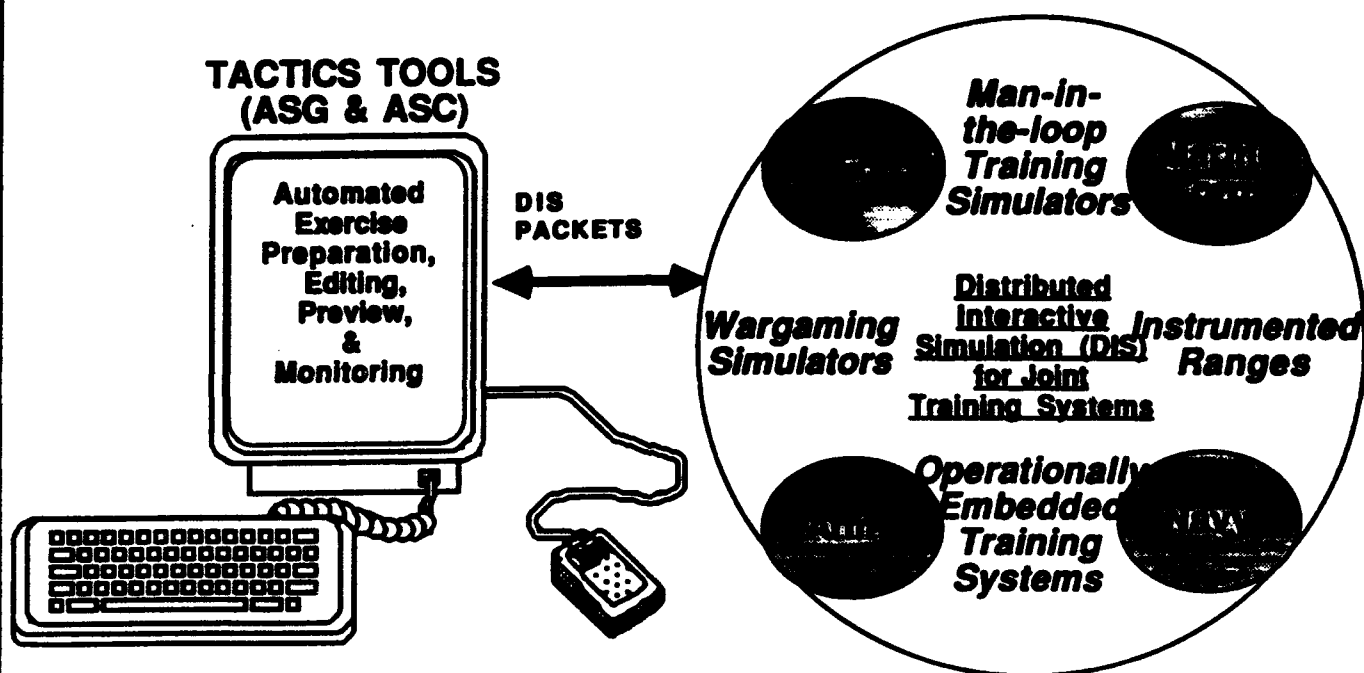
**Reduce Time and Effort
to Create & Monitor
Joint DIS Training Exercises**

ADVANCED COMPUTING APPLICATIONS
Principal Investigator - R. Soeldner
Code 25   Phone: 407/380-8202
DTIC Agency Accession Number: DN702027

BACKGROUND: There is a continuing need for high performance, low-cost computing for simulation in general, and training devices in particular. Some of the current problems which could be resolved with high performance computing are data visualization for instructor and students, complex battle force simulations, intelligent computer-directed adversaries, simulation of missing combat team members, intelligent computer-based tutoring, and many forms of animated displays. On the other hand there are a number of high performance computing elements, such as math coprocessors, digital signal processors, array processors, superscalar and pipeline architecture processors, graphics processors, and a myriad of parallel processors available on the open market which could be directly applied to these problems. For instance, the addition of a math coprocessor to a personal computer significantly increases the performance of the computer when used to solve scientific problems. Despite this, there has been little use of these computer technologies in resolving computer simulation problems. The reason for this seems to be the specialized programming required to effectively use these devices and the lack of library software directed toward simulation.

OBJECTIVE: The purpose of this task is to explore the possibility of extending the math coprocessor concept to the use of other high performance processors in the solution of simulation problems, by embedding highly iterative algorithms in the coprocessors and isolating implementation detail through the use of reusable Ada specifications.

BENEFITS: If this task can successfully demonstrate the feasibility of this concept, it could open the door to many low-cost computer simulation applications considered to be impractical because of computer run times. This task coupled with the Reusable Ada Repository for simulation, currently under development for NAVAIRWARCENTRASYSDIV, will provide a vehicle for widespread use of the products of this and follow-on efforts.

STATUS: A complete Ada specification was developed to describe the Position Keeping problem. The specification was written to use the features of Ada which promote reusability through object encapsulation. The Position Keeping problem is common to simulations and encompases much of the kind of mathematics which is needed for the solution of simulation problems. The specification permits keeping track of a variable number of entities in a variable size gaming area, real and non-real time entity updates, position data in both Latitude and Longitude and/or cartesian coordinates, range and bearing between entities, and visibility of entities to each other. A complete Ada test procedure was written to exercise the Ada specification. Implementations of the Ada specification were then done in Ada, C, Fortran and assembly language for the host processor, and C and Fortran for an Intel 860XP coprocessor. The purpose of the various implementations was to serve as a benchmark for determining if significant

performance improvements could be achieved using the hidden implementation feature of Ada. The results to date have been mixed. The research has demonstrated that an increase in processing speed of as much as a factor of 30 is possible; however, the coprocessor from which the greatest speed boost was expected showed no increase at all. The primary cause appears to be the inability of its compilers to take advantage of the super-scalar and pipeline architecture. This is significant because the trend in advanced microprocessors is toward this type of architecture. This problem area is continuing to be investigated. In addition, the development of the benchmark demonstrated a methodology for developing reusable software compatible with mixed language programming and external coprocessing. The methodology is now being applied to an ocean acoustics problem to test its generality and utility.

MAJOR MILESTONES:

Initial Performance Experiments	FY93
A practical simulation problem involving ocean acoustics and requiring high performance computing will be implemented	FY93
Demonstration involving the data visualization of multidimensional ocean acoustic data	FY94

ADVANCED COMPUTING APPLICATIONS
(REUSABLE SOFTWARE LINKAGE)

CPU   EXPANSION

ADA SIMULATION SOFTWARE

SOFTWARE LINK

SOFTWARE LINK

SOFTWARE LINK

SOFTWARE LINK

TRANSPUTERS

VECTOR PROCESSOR

MATH COPROCESSOR

GRAPHICS PROCESSOR

PERSONAL COMPUTER

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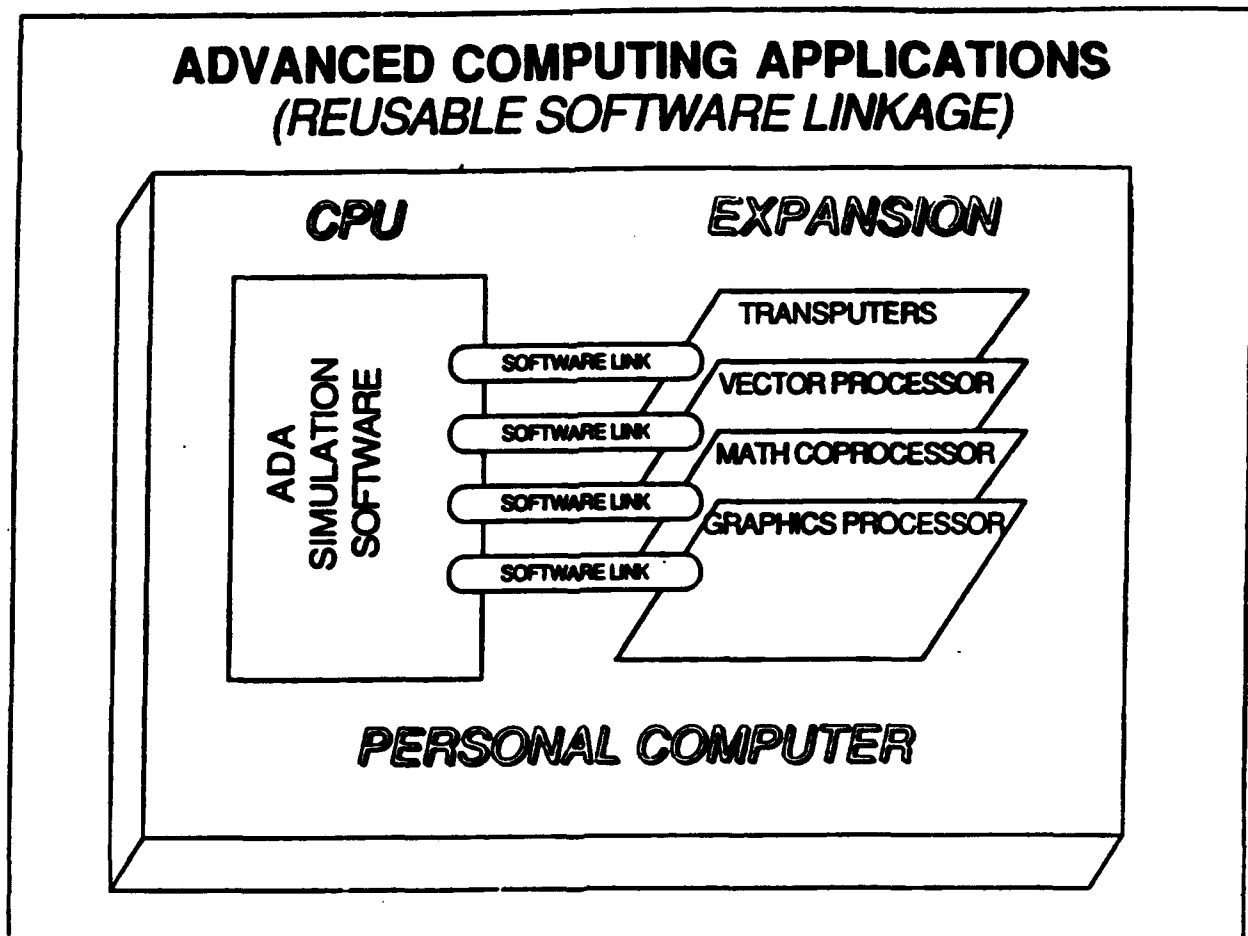
SONAR PROCESSOR SIMULATION
Principle Investigator - D. Paterson
Code 22 Phone 407/380-8564
DTIC Agency Accession Number: DN703013

BACKGROUND: Fleet SONAR operators are not fully utilizing the capabilities of their SONAR system. Operators are currently trained how to operate equipment, but not trained when and why to perform certain tasks. Training to increase knowledge of environmental effects and how an individual SONAR interacts with the environment needs to be improved. This has led to increased emphasis for a concept known as "SONAR employment" training. This training is expected to fill the gap between basic operator training (knobology) and tactical team training.

OBJECTIVE: The objective of this task is to develop technology to simulate the onboard SONAR processing.

BENEFITS: The ability to simulate onboard SONAR processing with medium to high fidelity will significantly reduce the cost for multi-seat advanced operator/employment trainers. The same modeling techniques will be relevant for air and surface platforms. The output from this effort will be a systematic approach to specifying and developing multi-beam SONAR simulations, with the ability to size the models to the desired fidelity. In addition, a full simulation will facilitate future integration with embedded performance measurements and other data required to support real-time SONAR employment instructional capabilities.

STATUS: Procured a system to be used as a signal processing workstation consisting of a PC/486 host processor, Digital Signal Processor (DSP) hardware, and commercial signal processing software and development tools. Performed an analysis of select receiver effects and tactical processing algorithms. The initial analysis is associated with narrowband search processes, and will ultimately include narrowband detection processes. Methods to simulate the beam effects and signal processes will be explored in conjunction with pre-stored scenario and environmental effects. At least two modeling approaches will be explored: (1) element simulation; and (2) beam output simulation. Processing models to create acoustically correct displays will be prototyped and hosted on the signal processing workstation (SpWS). Tactical display presentations will be generated from the pre-processed output of these models and demonstrated on the SpWS. Processing requirements for real-time implementation will be quantified based on the desired fidelity.

MAJOR MILESTONES:

Tactical Processor Analysis	FY93
IVBF/BF Model Development	FY94
Beam Simulation Model Dev	FY95
WS-SIG Proc. Display	FY95
Fidelity Analysis	FY95

SONAR PROCESSOR SIMULATION
Exploratory Approach

**Compare Two Approaches for Fidelity and Benchmarks
Using Signal Processing Workstation (SpWS)**

1.) Hardware/DSP Intensive Approach

Contact File Generation — Point Source / Multiple Paths → Inverse Beamformer — Element Data → Beamformer — Beam Output

Composite Path

2.) Simplified Simulation Approach

Contact File Generation → Det./Analysis Processing (Limited Beam/Path Set) → Data Representive of Single or Beam Set Avg.

Search Processing (Estimated Aperature) → Simulated Beam Set Output

To DSPs

To Display

SpWS Offline, Pre-Processed Models   **Online SpWS Models**

DIS OCEAN MODELS
Principal Investigator - L. Tuliano
Code 25   Phone: 407/380-8683
DTIC Agency Accession Number: DN703014

BACKGROUND: The Navy has an immediate need to develop a Distributive Interactive Simulation (DIS) Protocol Data Unit (PDU) for Ocean Modeling. The critical issue for this effort is ensuring that the Ocean DIS PDU will support a shallow water, range dependent ocean model. There is an additional requirement to provide the instructor display(s) which show multi-sensor and multi-threat ocean effects.

OBJECTIVE: The objectives are to evaluate a draft ocean DIS PDU for adequacy and to develop instructor ocean displays.

BENEFITS: Development of this technology will reduce the risk of errors or omission in the DIS PDU, provide a forum for the evaluation of changes and their associated impact to the DIS PDU, and establish a modular ocean modeling interface and display techniques which may be incorporated into larger complex training systems.

STATUS: The Geophysics Fleet Mission Profile Library (GFMPL) ocean modeling program was installed on a personal computer. The Acoustic Performance Prediction (APP) program used by the fleet has been requested and will be installed and demonstrated along with the GFMPL in FY94.

MAJOR MILESTONES:

Report preliminary finding on acceptability of draft ocean PDU to DIS Sea Subgroup	FY94
Demonstrate preliminary ocean information displays from GFMPL and APP for instructor guidance and understanding	FY94
Develop DIS PDU for WS#2 and LAN Link	FY95
Develop DIS PDU for WS#3 and LAN Link	FY96
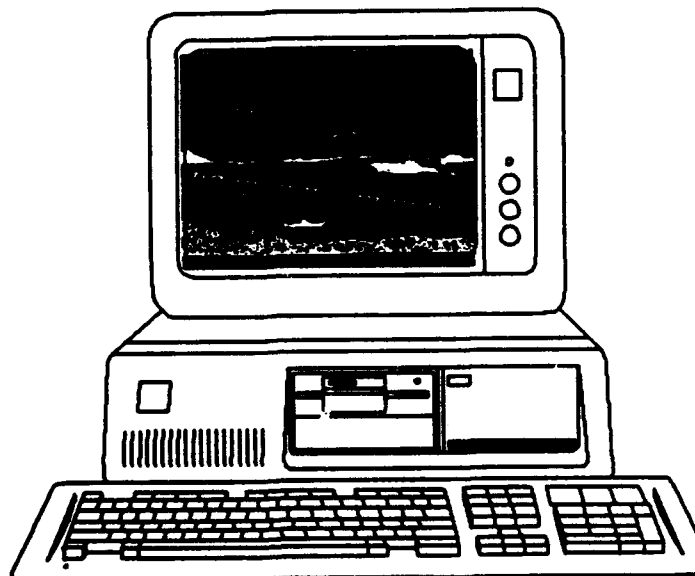
LOW COST PHOTO TEXTURE/DATABASES
Principal Investigator - J. Booker
Code 25   Phone: 407/249-3122
DTIC Agency Accession Number: TBD

BACKGROUND: The costs of visual CIG databases have remained excessively high during recent years and are responsible for continuing high visual simulation costs. Recent training systems have encountered typical visual database costs ranging from $100K to $300K per application to over a million dollars for a completely new database application on one of the older high end CIG systems. These costs are excessive for the new low cost workstation level CIG systems where the per channel costs have gradually been reduced to range between $100K and $150K per channel. A ratio of 10-to-1 between hardware and database software would be more appropriate. A target cost of less than $25K per application database represents a practical goal for demonstrations under this task. The use of texture, new data acquisition techniques, interactive graphic interfaces, and innovative marketing concepts can significantly reduce database development costs.

OBJECTIVE: The objective is to exploit new hardware and software technology to reduce costs for visual databases.

BENEFITS: The use of photo based texture is one of several new methods to increase visual complexity while reducing the amount of geometric complexity (i.e. shape) in the database description. Reduced database complexity translates directly into reduced database programming costs. Improved man/machine programming interfaces also result in increased programmer productivity and reduced visual database

costs. The use of photogrametric data acquisition techniques combined with recent hardware advances in location and digital data acquisition devices can also reduce database development costs. Both generic and geospecific shiphandling, surface, and aircraft application databases will be developed using the new software tools and photo texture techniques to demonstrate the ability to reduce database acquisition costs. New contractor sources will also be sought for low cost visual databases.

STATUS: This is a new task addressing software issues which is transitioning from a hardware oriented task, "CIG Cost/Performance Enhancement," which emphasized the low cost CIG workstation technology areas. Activities under this task will include interactive data acquisition technology, generic and geospecific phototextured databases, and new low cost visual database contractor sources.

MAJOR MILESTONES:

Develop interactive software and data acquisition techniques	FY95
Develop/acquire low cost phototextured databases (generic and geospecific)	FY97
Continue VOLUME Database Object Library and Government Users Group	Annually

VIRTUAL ENVIRONMENT TRAINING TECHNOLOGY
Principal Investigator - D. Fowlkes
Code 26   Phone: 407/380-4789
DTIC Agency Accession Number: DN702024

BACKGROUND: Virtual Environment (VE) technology is a newly coined term which encompasses a number of display and transducer technologies designed to make human-computer interfaces more efficient and effective. VE technology differs from conventional training simulator technology in that the human computer interface in a simulator is hardware specific to the real world equipment being simulated. Whereas, the interface in a VE system is designed to be specific to the human user's needs for sensory inputs and control outputs with little or no hardware specific to real world equipment. Ultimately, a single VE interface could provide a user with any training environment for any piece of operational equipment. The VE interfaces the trainee user with a training system using displays and transducers. Displays provide information to the user from the training system computer while the transducers relay information from the user to the training system computer. Displays for VE which currently are being developed for VE applications include visual, audio, tactile, and force. Transducers include position, orientation, speech, and force.

OBJECTIVE: This project will analyze and demonstrate the feasibility of using VE technology to improve the efficiency and effectiveness of military training. VE will be evaluated as a training delivery medium; as a replacement for current training media; as an enhancement to current training media; and as an enabling technology capable of providing training in areas where existing training media are inadequate.

BENEFITS: The utilization of VE in military training applications is expected to be an evolutionary process. Existing VE technology is relatively crude and may have limited cost and training effectiveness benefits. Initially, this project will identify the types of training which will benefit from VE technology at its current level of development and provide design guidelines for advanced development for specific training applications. Experience gained from the initial investigations will result in the specification of performance characteristics and features of display and transducer components which will allow application to additional training areas. As these component performance capabilities are developed, additional training areas will be addressed and transitioned.

STATUS: Work has been accomplished in three areas. Task 1 - Visualization of Three Dimensional Environments: Several iterations of the V-ADS have been developed, designs have been developed for further "virtualization" of the aircrew debrief station, and an evaluation methodology has been developed and used for extensive data collection and analysis. Task 2 - Console Operation: Research and development has been initiated in several areas of VE component technologies necessary for a virtual training console. The focus is on three-dimensional visual displays, the human haptic system, and sensorimotor loops.

Task 3 - Operation of Platform: The Virtual Environment Research Test Bed including interfaces, computer, video recording and playback capabilities, and software is currently being developed; and research is underway to examine real and virtual motion, spatial disorientation and motion sickness symptomatology, and virtual controls.

MAJOR MILESTONES	
Assess State of the Art	FY92
Establish Test Bed	FY93
Initiate Research	
Haptic	FY93
Sensorimotor Loops	FY93
Disorientation	FY93
Visualization	FY93-FY94
Console Operation	FY93-FY95
Platform Operation	FY95-FY97

VIRTUAL ENVIRONMENT TRAINING
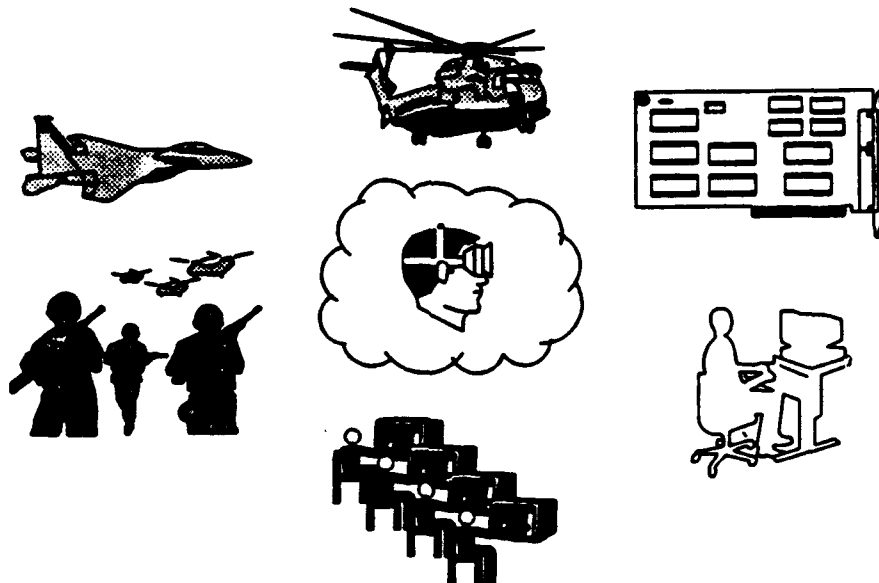
TACTICAL DECISION MAKING UNDER STRESS
Principal Investigators - E. Salas/J. Cannon-Bowers
Code 26   Phone: 407/380-4651
DTIC Agency Accession Number: DN700019

BACKGROUND: As a result of recent combat events, a fundamental reassessment of requirements for a wide range of Navy systems is taking place. Emphasis is now beginning to shift to the problems of dealing with low- and mid-intensity conflicts where events fit multiple possible hypotheses with respect to contact identification, intent, aliable responses and their consequences At present, state-of-the art, real-time battle management systems are based on doctrine that is well suited to problems that might be encountered in all-out war, but may not be optimum for the problems inherent in less than full-scale warfare. Recent events, such as the one involving the USS Stark, where the decision not to initiate countermeasures was the incorrect one, and the USS Vincennes, where the opposite decision was the incorrect one, have focussed attention on the human factor in decision making under low- and mid- intensity conflict. The catastrophic costs of these decisions dictate that improved support must be provided to the tactical decision maker in these unexpected, highly charged, extremely short-duration, confusing situations where it is not clear who the enemy is, let alone what he intends to do.

OBJECTIVE: The objective is to apply recent developments in decision theory, individual and team training, and information display to the problem of enhancing tactical decision quality under conditions of stress. This will be accomplished by a cooperative program in human factors and training involving the Naval Command and Control Ocean Surveillance Center Research and Development (NCCOSC/NRAD) and NAVAIRWARCENTRASYSDIV as well as Navy, industrial, and academic organizations. The technology will be demonstrated and evaluated in the context of surface ship anti-air scenarios.

BENEFITS: The results of this effort will be an enhanced understanding of human decision making processes and a set of training and simulation principles that will lead to improved individual and team tactical decision making under conditions encountered in low-intensity conflict situations.

STATUS: Fleet contacts were maintained and expanded in FY93, with numerous visits to operational and training sites. Laboratory simulation and test facilities, referred to as DEFTT (Decision-making Evaluation Facility for Tactical Teams) were established at several locations, including NRaD, San Diego; TAO School, Dam Neck; Surface Warfare Officers School (SWOS), Newport, and Navy Post-Graduate School, Monterey. DEFTT provides realistic simulation, and all necessary tactical cues to simulate a multi-threat battle problem.

With respect to performance measurement, several measurement scales were tested and refined in FY93. Results of initial data collection indicate that scaling formats are sufficiently valid and reliable to warrant further use. In addition, subject matter expert acceptance of scales has been high. Also in FY93, scenarios were finalized via the Stress Assessment Methodology, which allows a systematic calibration of workload and uncertainty in scenarios. In addition,

experimental protocols, introductory materials and briefing materials were all finalized and tested.

Baseline data collection began in FY93 with a variety of teams. Results of these efforts indicated that performance measures, scenarios and the experimental facilities are sufficient to test hypotheses regarding training and decision support interventions.

Considerable attention was given to defining further the training interventions to be tested. This included specifying approaches such as: automaticity training, pattern recognition training, stress exposure training, team mental model training, coordination training and leadership training.

MILESTONES:

Test principles and recommendations for the development of team instructional strategies	FY94
Guidelines for application of performance measures and scenario development techniques for use in CIC training	FY94
Test principles and recommendations for the development of decision support system training	FY95
Guidelines for application of training techniques for use in CIC training systems	FY95

AEGIS DISPLAY SYSTEM
CONSOLE OPERATORS

INDEPENDENT RESEARCH - 6.1
Program Manager - J. Deaton
Code 261   Phone: 407/380-4132

The Independent Research (IR) program provides discretionary funds for basic research to the technical directors of Navy laboratories and centers, and the Naval Medical Research and Development Command. The program provides an opportunity for Navy scientists and engineers to pursue new and innovative research and technology areas for the solution of Navy and Marine Corps problems. Scientists and engineers conduct self-initiated research and development with emphasis on simulation and training device technologies. This presents several advantages.

First, The IR program is a basic source of new concept seed money to support investigations salutary to significant technological growth. These investigations can involve efforts on more speculative approaches that are too risky for funding by existing programs. Second, scientists and engineers build in-house expertise in areas of future importance. These skills enhance the "smart-buyer" capability of NAVAIRWARCENTRASYSDIV and provide necessary technical skills to assess development and acceptance of innovative trainers. There is no other Navy organization charged with, or capable of, the breadth and depth of the mission of multi-platform, joint service training system research, development, acquisition, and logistical support.

Many ancillary benefits are derived from the IR program, such as: the shortening of the time scale of programs; the solving of road block problems that cause delays in programs; a means of rewarding high quality ideas; extending research support for creative scientists and engineers; and providing a stimulating atmosphere conducive to generating new concepts and challenging ideas.

A description of a continuing FY93 IR task follows. Additional FY94 project proposals are currently under review.

ALARM RESPONSIVENESS
Principal Investigator - J. Deaton
Code 261   Phone: 407/380-4132
Co-Investigator - R. Oser
Code 262   Phone: 407/380-4818
DTIC Agency Accession Number: DN703006

BACKGROUND: The role of human operators with future complex systems is changing from direct control to one of supervision r^ sub-system automation. The term, human-centered automation, suggests a strong interactive role for humans in the decision-making process of how complex systems will operate. This is especially true for military systems where the consequences of automated errors are high. The activity of an automated sub-system is typically monitored with built-in alerts and alarms, e.g., for system status and failures. The number of monitoring devices is likely to increase as cost and availability of both automation and system sensors increases.

It is well-documented that human responses to complex system failures can be inappropriate, even disastrous. The Three Mile Island nuclear power plant incident is only one of such world infamous events, standing as testimony to our lack of understanding in emergency situations. Questions such as alarm prioritization, reliability, criticality, and human response to multiple alarms were raised in the wake of a number of such subsequent world-known events.   Past assumptions concerning human responses to alarms are likewise being challenged.

OBJECTIVE: The aim of this research is two-fold.   First, to increase the understanding of human responses to system alarms, and thereby increasing individual and team response effectiveness to system alarms. The second phase will

focus on the development of training guidelines and principles that will assist trainers in developing methods to help operators deal more effectively with discriminating and prioritizing an array of diverse multi-channel alarms. The initial task will explore fundamental issues involved in the expectations and reactions to alarms, e.g., reliability and criticality. The second task will be to understand the effect of multiple alarms in operational-like environments.   The third task will serve to provide knowledge for the development of training and design standards or guidelines for setting response priority in multiple alarm situations.

BENEFITS: Successful completion of this research will: (1) Delineate how operator responses to alarms may be altered or delayed, by several variables, e.g., perceived reliability and criticality. Clarification of these effects could lead to alerting systems that are more effective or attention-getting; (2) Assess the effects of operator responses to multiple alarms, e.g., those that occur with complex system failures or with simultaneous vigilance tasks; and (3) Provide guidelines and principles for multi-alarm priority setting, with respect to training implications and to potential designs using artificial intelligence.

STATUS: The first of several experiments has been completed. This initial study sought to substantiate the existence of the "cry-wolf" effect (i.e., a

reduction in responses due to a large false alarm rate), noting its effect on primary task and alarm response performance, and to examine the relation between the cry-wolf effect and alarm criticality. Data from this study are currently being analyzed.
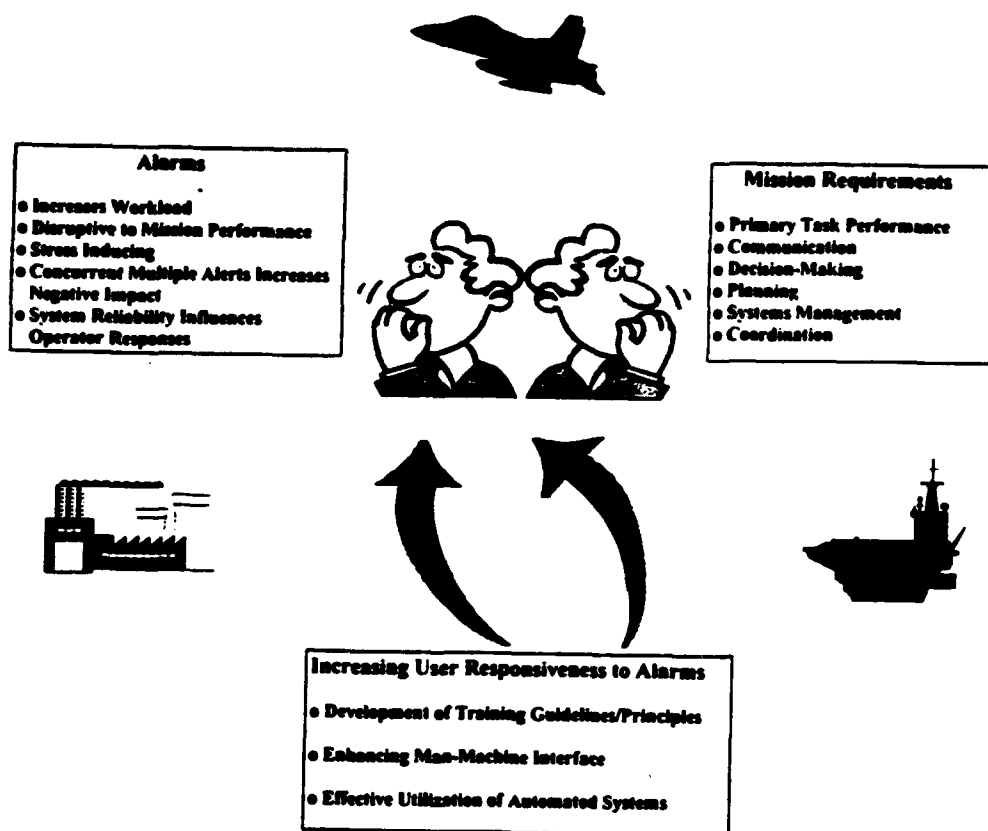
A report was completed detailing the implications of multiple alarms for training. This paper: (1) identified the need for studies investigating design and training issues associated with multiple alarms; (2) presented an overview of the current characteristics of multiple alarm systems specific to aviation; (3) provided a basic theoretical framework and research paradigm for investigating human performance and training issues with

multiple alarm systems, and (4) described the implications of multiple alarm research to enhance the development of individual and aircrew training techniques with advanced systems.

Work in FY94 will focus primarily on the development of a more operationally relevant testbed, and examine the effects of multiple alarms on operator performance.

MAJOR MILESTONES:
Phase I: Responsiveness to   FY93
False Alarms Research
 Phase II: Responsiveness to   FY94
Multiple Alarms Research
Phase III: Alarm Priority Training FY95

Alarms
- Increases Workload
- Disruptive to Mission Performance
- Stress Inducing
- Concurrent Multiple Alerts Increases Negative Impact
- System Reliability Influences Operator Responses

Mission Requirements
- Primary Task Performance
- Communication
- Decision-Making
- Planning
- Systems Management
- Coordination

Increasing User Responsiveness to Alarms
- Development of Training Guidelines/Principles
- Enhancing Man-Machine Interface
- Effective Utilization of Automated Systems

JOINT-SERVICES R&D PROGRAM - 6.4
Program Manager - J. Weisenford
Code PDR2   Phone: 407/380-8276

The objective of this program is to expedite the prototype development of new training technologies and joint-service training data systems that improve training effectiveness and enhance the performance of the military forces. The program was established by the Secretary of Defense to improve training, performance, and readiness of the military departments and reserve components. It also saves DoD funds through the sharing of training and performance information as well as the transfer of emerging and innovative training technologies among the services and private sector. The payoff includes early identification of successful single-service efforts that can be employed on a multi-service/DoD-wide basis for improvement of military operations and training.

WEAPONS TEAM ENGAGEMENT SIMULATION
Principal Investigator - A. Marshall
Code 25   Phone: 407/380-4653

BACKGROUND: Many simulator-based weapon team trainers currently use technology which restricts both realism and the ability for thorough team performance measurements in tactical training situations. The Weapons Team Engagement Trainer (WTET) uses new technology to improve simulation training for weapon fire teams. These new developments include intelligent video branching, location detection of trainees, interaction between trainees and their on-screen aggressors (shoot-back), computer networking of multiple video projection screens within multiple rooms, a wireless data communication system allowing full unrestricted mobility, a high speed weapon tracking system, and a digital MIDI controlled sound system.

OBJECTIVE: The objective of this task is to develop new technology and techniques to improve current weapon team training systems.

BENEFITS: A typical trainee can expend over 5,000 rounds of ammunition during one week of live fire training, which is estimated to cost $905.00. In addition to the savings in ammunition, other benefits are savings in the cost of facilities, ranges, fuel, and transportation to and from the live fire ranges. Safety is also a concern since the WTET uses no live ammunition; the dangers of an inadvertent weapon discharge or lead poisoning is eliminated.

Continuously tracking weapon aiming points for all members of a fire team expands performance measurement and playback capabilities. Training effectiveness and realism are also increased because aggressors fall when hit and trainees are required to take appropriate cover when an aggressor returns fire. This results in an increase in communication and awareness between members of the team. Multiple screens and no cables allow the trainees to maneuver freely inside several different areas.

The system includes tracking trainees' movements to both control shoot-back and enhance feedback, video recording of the trainees, an expert system to control the video scenarios, and an analysis of the results for debriefing using an expert system. The system also contains no cables to the trainees, allowing free movement inside the trainer.

STATUS: An evaluation model has been developed that allows up to nine trainees to practice and rehearse close combat training exercises. These exercises include low intensity conflict, light infantry, SWAT, and security operations, with a high level of realism and feedback. Typical events might include security operations, hostage rescue, shoot-no-shoot, ambush training situations, and routine law enforcement operations in a common team scenario environment. An innovative weapon tracking system which generated accurate weapon position data at over 300 Hz was designed and constructed which is capable of continuously tracking weapon aiming points for up to 9 trainees. A communications link eliminates the need for cable to the computer system. Four patent applications have been awarded on this system.
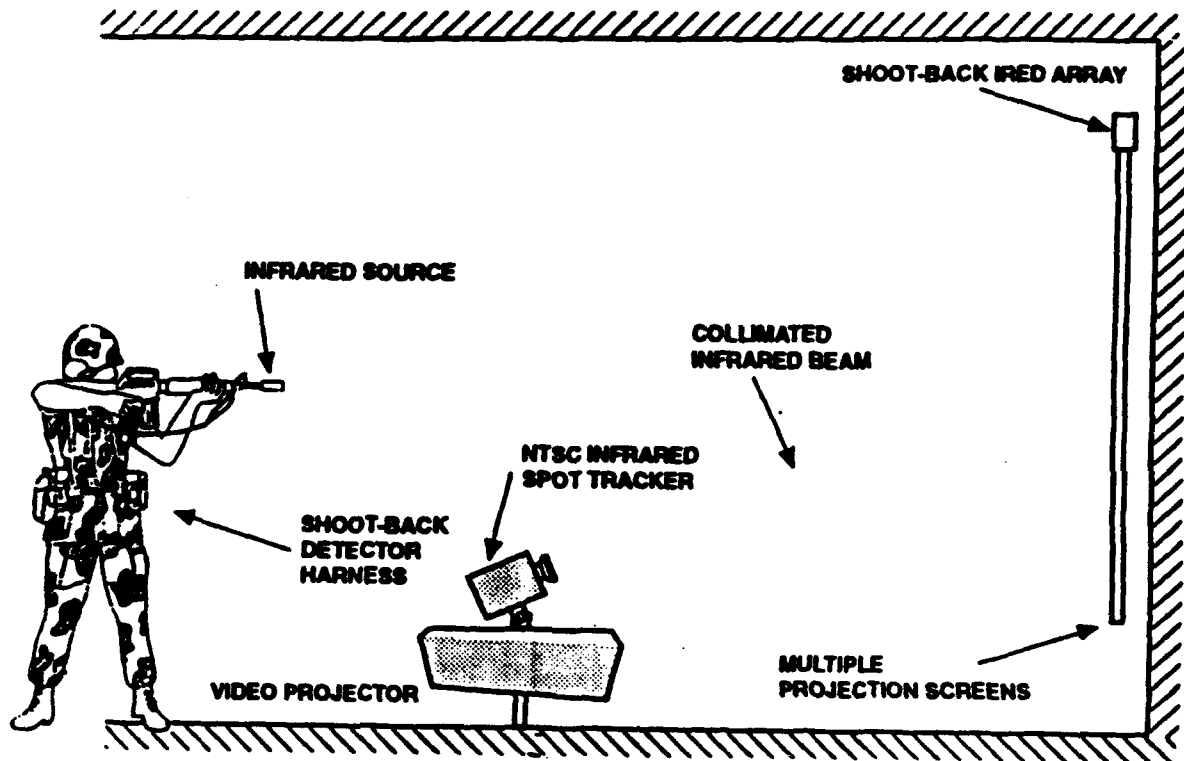
MAJOR MILESTONES:

Design System	FY91
Fabrication	FY92
Training Effectiveness	FY93/94
Evaluations	

Weapons Team Engagement Trainer Configuration

SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) PROGRAM - 6.2
Program Manager - J. Weisenford
Code PDR2   Phone: 407/380-8276

The Department of Defense (DoD) SBIR program was developed to stimulate technological innovation in the private sector, strengthen the role of small business in meeting DoD R&D needs, foster and encourage participation by minority and disadvantaged persons in technological innovation, and increase commercial application of DoD supported R&D results. Small business firms with strong R&D capabilities in science and engineering are encouraged to participate in the program. Subject to availability of funds, the program supports R&D proposals for innovative concepts related to important defense-related scientific or engineering problems.

The SBIR program is a 3-phase program:

Phase I is to determine the scientific or technical merit and feasibility of ideas. This will typically be one-half person-year effort over a period not to exceed six months. Successful completion is a prerequisite for funding in Phase II.

Phase II awards are made on the basis of results from Phase I and on the scientific and technical merit of the Phase II proposal. This phase is the principal research or R&D effort. Proposers are asked to consider whether the R&D they are proposing also has commercial possibilities. If so, proposers are encouraged to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funding phases. Phase II typically covers 2 to 5 person-years of effort over a period generally not to exceed 24 months. Phase II is expected to produce a well defined deliverable product or process, and a more comprehensive proposal is required.

Under Phase III, non-federal capital is expected to be used by the small business to pursue commercial applications of the R&D. This phase is designed, in part, to provide incentives for converting federally-sponsored R&D innovation in the private sector.

To request copies of the SBIR solicitation, contact the Defense Technical Information Center, Attn: DTIC/SBIR, Bldg 5, Cameron Station, Alexandria, VA 22304-6415; telephone 1-800-368-5211 (Virginia, Alaska and Hawaii call 202/274-6902.) The solicitation provides information on how to submit proposals.

The following topics are included in the DoD 94.1 SBIR Solicitation:

Low Cost, PC-Based Navigational Skills, Air Traffic Control, and Crew Coordination Training Tool

OBJECTIVE: Develop a PC-based crew coordination and navigational skills training tool that could be used for aviator training.

BACKGROUND: Aviators do not have enough opportunity to practice navigation and crew coordination skills in actual aircraft or simulators. A PC-based training aid would provide an opportunity for practice when deployed away from conventional training sites. In addition to piloting an aircraft, maintaining proficiency in the combined task of following air traffic control (ATC) instructions, navigation, and crew coordination can be difficult. The PC-based simulation would simulate ATC and other voice traffic to which the pilot would respond. The system will consist of a low fidelity flight simulation system with a database with user definable attributes that could be used with actual air charts. Also to be included, development tools to allow the user to create simulated radio traffic. The system should include representative flight models, user definable weather conditions, and software tools to provide an analysis of the training session. The use of existing software and hardware is encouraged.

BENEFITS: Poor crew coordination is a major factor in air accidents. This effort will provide a low cost tool for aircrew coordination training.

Low Cost Real-Time Stereoscopic Multiplanar Display Development for Future Navy Battle Management Training Systems

OBJECTIVE: This effort will develop a prototype for a low cost battle management system which utilizes real-time stereoscopic multiplanar display to create true three-dimensional training scenes in realtime (update of 30 hertz per second). The display subsystem will create a true real-time three-dimensional image which can be viewed from all sides by several people.

BACKGROUND: Most of the Navy battle management training systems utilize terrain boards or 2D graphics to simulate 3D scenes for modeling geographic areas. Terrain boards lack simulation of time of day, atmospheric effects, and special effects. Two-dimensional graphics does not provide true parallax motion cues which real-world images give. These limitations can be overcome by generating a true realtime three-dimensional simulated scene.

BENEFITS: Current simulations do not offer 3D scenes and are, therefore, less realistic than desired for training. This would take advantage of low cost technology to provide this capability.

Special Effects for Ocean Computer Image Generation (CIG) Visual Simulation

OBJECTIVE: Develop low cost simulation of certain dynamic ocean effects.

BACKGROUND: Simulations of certain ocean effects (whitecaps, foam, spray from the bow of a ship as it goes through water) are not currently available on existing commercial or military simulators. These effects present cues for landing helicopters. This effort will develop the simulation of special effects for dynamic ocean simulation using the latest low cost CIG workstation capabilities.

BENEFITS: This effort will improve visual systems for helicopter training by integrating dynamic ocean effects into the simulation. Through the use of low cost CIG workstations, these special effects will be affordable. This will increase the opportunity for using simulation to train skills which use visual cues.

Portable 3D Data Acquisition Technology for Computer Image Generation (CIG) Visual Databases

OBJECTIVE: Develop a portable system for capturing surface/low altitude 3D data for use in visual systems.

BACKGROUND: Realistic visual systems use geometric shapes and texture to portray oceans, navigational cues in ports, and terrain. New technology is available for potential use in capturing and manipulating the data to convey the detail needed for effective training. This technology includes digital cameras, GPS receivers and CIG work stations which capture geometric shapes and textures.

BENEFITS: The results of this effort will improve the quality of visual systems and reduce the costs.

KNOWLEDGE-BASED INTELLIGENT TUTORING SYSTEM (ITS) DEVELOPMENT TOOL FOR TABLETOP TRAINING SYSTEMS
Principal Investigator - T. Kopke
Code 25   Phone: 407/380-4589
DTIC Agency Accession No. DN703035

BACKGROUND: Intelligent Tutoring Systems (ITSs) typically take a significant amount of time and resources to develop. Some of the components, such as those that manage the training session and student performance, could be predefined so that ITS development would take less effort. The tool itself should be based on expert system technology, both for control over the development environment and for final ITS execution. Given such an ITS development tool on a low-cost, tabletop computer system, the course writer need only concentrate efforts on the specifics of the information to be learned by the student.

OBJECTIVE: To design and develop a low-cost, intelligent, tabletop trainer development system. The system would enable rapid prototyping of ITSs.

BENEFITS: Development of tabletop trainers would require significantly fewer resources, enabling greater deployment of the technology.

STATUS: This awarded Phase I effort will investigate design and pedagogical issues regarding a PC-based, multi-media system. This is a new award.

GAS MASK SENSOR TO DETECT
WHETHER MASK IS FULLY SEALED
Principal Investigator - T. Franz
Code 26   Phone: 407/380-4631
DTIC Agency Accession Number: DN703019

BACKGROUND: The ability of personnel to don the gas mask quickly and effectively is basic to survival in a chemical environment. Although the protective mask is the single most crucial article of chemical defense equipment, there is no current training-effective shipboard method for mask donning drill. Mask training currently takes place during Recruit Training. The training consists of entering a tear gas chamber while wearing the sealed mask, breathing through the filter a few times, and then removing the mask so that the contrast with the protected state is appreciated. This method of training is not feasible for a shipboard environment. Also, research has indicated that the tear gas chamber exercise sometimes decreases confidence rather than promoting it. This occurs because many students are unable to seal their masks, but they do not report their failure for fear of having to repeat the exercise.

OBJECTIVE: Objectives are to identify the best system for measuring gas mask leaks and to identify parameters needed to establish an acceptable fit criterion for gas masks used by the Navy. The device is to be used in training exercises to enhance performance of the mask donning task and provide objective feedback.

BENEFITS: Use of a sensor to indicate whether or not the mask is fully sealed would provide objective feedback to the mask wearer as well as to the instructor. The immediate and objective feedback provided will greatly enhance the mask donning practice.

STATUS: Three reports have been accepted: Controlled Negative Pressure Technology, Aerosol Based Technologies, and Gas and Vapor Technologies.

MAJOR MILESTONES:

Comprehensive review of technologies	FY93
Trade-off analysis to select most cost-effective method	FY93
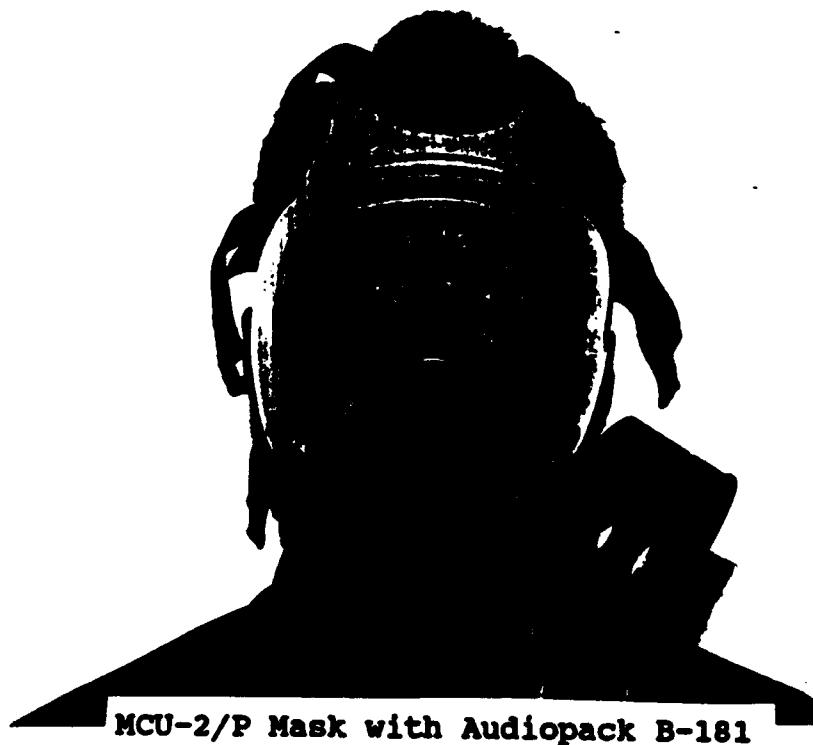
MCU-2/P Mask with Audiopack B-181

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LOW COST COMPUTER IMAGE GENERATOR FOR NIGHT VISION

Principal Investigator - T. Kopke
Code 25   Phone: 407/380-4589
DTIC Agency Accession Number: DN703005

BACKGROUND: Efforts are currently underway to develop low cost display systems to simulate night vision goggles for use in flight training simulators. A low cost image generator is needed to drive these displays. The computer image generator is different than the usual CIG found in simulation because the NVG display is monochrome. The low cost generator should be capable of displaying night vision terrain for use in flight simulation. The data base created for the low cost CIG will coordinate with an existing daylight data base. Provisions for inputs of flight parameters, data base location, and attitude are required. Since NVG viewing window can change dependent on the simulated flight, a provision for input of head attitude information will be provided.

OBJECTIVE: The objective of this effort is to design and construct a prototype low cost computer image generator.

BENEFITS: The final product will have operating features and performance comparable to image generators that cost $200K-$300K currently being used for visual simulation. The target cost will be approximately $100K for a system that will have photo texturing and true perspective. The lower cost and modular design will allow easy modification to adapt to a variety of low cost simulation approaches while maintaining scene fidelity that is required for many tasks such as NVG training.

STATUS: A Phase II effort is currently underway. Preliminary hardware and software design has been completed. Physical construction of the prototype has begun along with the development of operating software and a simple database. The system is being developed as a total integrated image generator and display system that will incorporate products of two other SBIR efforts. The system is to be demonstrated in the Fall of 1993.

LOW COST NIGHT VISION GOGGLES FOR SIMULATION
Principal Investigator - T. Kopke
Code 25   Phone: 407/380-4589
DTIC Agency Accession Number: DN702037

BACKGROUND: The increased use in night vision goggles (NVG) for flight has prompted the need for night vision flight training. Night vision systems used in flight have a limited field of view and do not allow for use of periphery cues when flying nap of the earth. A low cost display system that mimics operational NVG hardware for simulation training is needed. The low cost simulated monochrome NVG display will have display rates compatible with current flight simulation computer image generators and will be comparable in weight if worn on the head. Optical and physical parameters will be, or similar to, that of operational NVGs.

OBJECTIVE: The objective of this effort is to design and construct two prototypes based on two different display technologies: liquid crystal display (LCD) and cathode ray tube (CRT). The final delivered products will simulate the ANVIS NVG system that would accept standard video from either computer image generation or video disk based image generation systems.

BENEFITS: The final NVG system would allow NVG training in any dome simulator and would not be restricted by display type inside the dome. Because of the emphasis on low cost, NVG training could then be performed in a low cost simulation environment, such as part task or a classroom, allowing additional NVG training opportunity.

STATUS: Phase II efforts are currently underway. A prototype of a CRT-based version modeled to simulate the ANVIS NVG has been delivered. A similar development is progressing to provide a LCD-based version also modeled to simulate the ANVIS NVG. Both versions are designed to operate using a pilot's own helmet. The CRT version is undergoing integration with a concurrent second SBIR effort for a low-cost CIG system and a past SBIR developed head tracker to be demonstrated the Fall of 1993.

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ANCILLARY FUNDED TASKS

During the normal cycle of program reviews, some Navy R&D sponsored efforts are found by others to contain elements which apply to their own requirements. When this happens, NAVAIRWARCENTRASYSDIV examines the similarities and differences in requirements and applications. A determination is made as to whether there is a significant issue and, if so, who is best able to pursue the technology.

Likewise, the Navy trainer community's review of emerging R&D identifies applications which were not considered during technology development. A determination is made as to whether a modification to the on-going effort would allow expansion to these additional applications or to establish a special task.

The tasks in the following section were determined to be pursued best by NAVAIRWARCENTRASYSDIV due to special talents, capabilities, or facilities. They may be funded by other Navy activities, other services, or DoD agencies.

SIMULATOR SICKNESS ASSESSMENT PROGRAM
Principal Investigator - S. Jones
Code 26   Phone 407/380-4152

BACKGROUND: Advances in aviation training system technologies have improved training effectiveness and user acceptance. However, increased sophistication of visual and motion systems has produced a constellation of motion sickness symptomatology in simulator users, known as simulator sickness. An extensive knowledge base from the behavioral sciences exists which indicates a strong relationship between the illusory perception of self-motion (vection) and motion sickness symptomatology. As simulation fidelity becomes increasingly convincing (i.e., vection-inducing), even slight deviation from normal visual, vestibular and proprioceptive correspondence is likely to induce sickness.
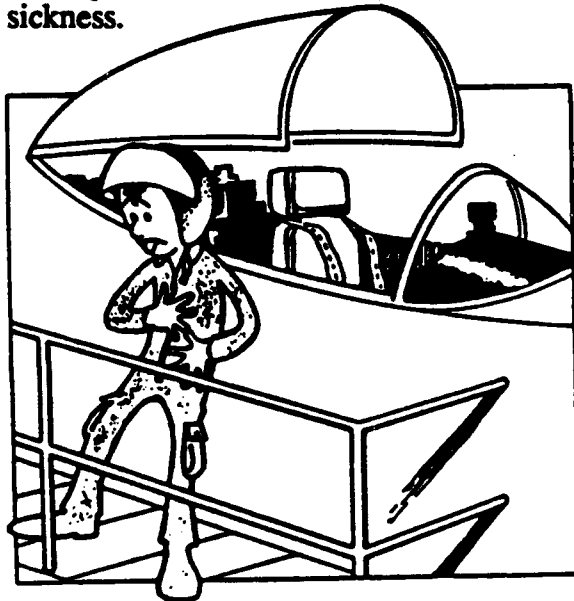
OBJECTIVE: NAVAIRWARCENTRA-SYSDIV supports NAVAIRSYSCOM in a comprehensive program to reduce the incidence and impact of simulator sickness. The objectives of the program are to address each of the following areas of concern: (1) Engineering specifications and testing protocol; (2) R&D to determine the extent to which

symptomatology is a function of specific simulator engineering configurations as well as visual and inertial stimulus input; (3) usage guidelines; and (4) systematic monitoring of incidence rates.

BENEFITS: A reduction in the incidence of simulator sickness for any given trainer will: a) reduce safety and health risks (including locomotor ataxia, interference with higher-order manual control, physiological discomfort, and visual aftereffects or flashbacks); b) increase operational readiness through relaxation of mandatory grounding policies; c) enhance training effectiveness and pilot acceptance; and d) exercise the use of engineering capabilities to their fullest extent.

STATUS: NAVAIRWARCENTRA-SYSDIV is providing technical support for a NAVAIRSYSCOM sponsored effort to develop continuous on-line measures of the kinematic characteristics of the visual and inertial input. An investigation of the relationship between simulator platform motion (on vs. off), visual display type (CRT vs. wide-angle display), and the incidence of simulator sickness is ongoing. A test plan has been prepared to compare the relative incidence of simulator sickness resulting from helmet-mounted displays (HMD), domes, and CRT displays.

MAJOR MILESTONES:

Develop Measures of Visual Display Kinematics	FY93
Examine Contributions of Visual Display Kinematics	FY94
Technical Report on Contributions of Motion Platforms	FY94
Technical Report on Contributions of Display Kinematics	FY95

DEVELOPMENT OF COST AND TRAINING EFFECTIVENESS STANDARDS

Principal Investigator - G. Micheli
Code 26   Phone: 407/380-8282
DTIC Agency Accession No. DN703002

BACKGROUND: The Office of the Assistant Secretary of Defense for Force Management and Personnel (OASD/FM&P) has a requirement to monitor the effectiveness of military training within the DoD to ensure that military training is allocated sufficient resources to maintain combat readiness. As part of this requirement, decision makers for training system design need executive level information on simulators/simulations and their effectiveness, particularly with regard to team training. There is a need to define cost and training effectiveness of training systems in order to support many of the upcoming applications of simulated distributed environments for both service interoperability and joint training.

This project supports FM&P Readiness and Training with the development of a DoD standard for evaluating the cost and training effectiveness of training systems. This will require a comprehensive assessment of the scope and efficacy of cost and training effectiveness analysis methodologies and an identification of methods, data requirements, and common variables relating to assessing DoD training systems. The lack of a DoD standard for cost and training effectiveness evaluation makes it difficult to ensure that training systems are meeting training requirements at an affordable cost. The lack of consistent and reliable cost and training effectiveness data makes it difficult to link training and readiness and to justify training system funding requirements.

OBJECTIVE: The objective is to develop a DoD standard for evaluating the cost and training effectiveness of DoD training systems.

BENEFITS: The development of a DoD standard for evaluating the cost and training effectiveness of training systems will provide a tool for government decision makers to make proper choices about optimal training system design and cost. It will also assist in quantifying the effectiveness of DoD training systems in terms of operational/combat performance and impacts on readiness.

STATUS: Current methodologies of cost and training effectiveness evaluations are being assessed.   Potential variables, methods, and needs for a DoD standard are being identified. A standard for cost and training effectiveness evaluation of team training systems is being developed.

MAJOR MILESTONES:

Report on potential cost and training effectiveness variables, methods and data reqm'ts	FY93
Report on recommendations for use of cost and training effectiveness methodologies	FY93
DoD standard for evaluating the cost and training effectiveness of DoD training systems	FY93
Technical report to document efforts, findings, recommendations, and products from the study	FY94
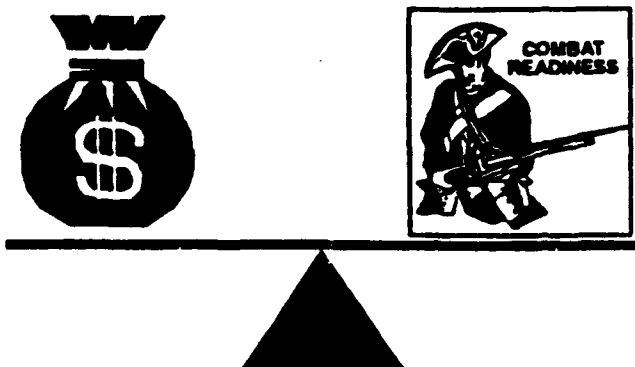
TECHNOLOGY TRANSFER
Point of Contact - J. Weisenford
Code PDR2   Phone: 407/380-8276

The Federal Technology Transfer Act of 1986 requires federal agencies to optimize the investment of tax dollars in R&D by sharing knowledge and products with other organizations, both public and private. The Act provides for joint research projects between federal laboratories and others as well as commercialization of laboratory products. It also encourages federal laboratories to provide technical volunteers to the community in which they are located.

Through technology transfer, Congress believes that there will be significant benefits to the public. Congress noted that many government patents were not licensed and, therefore, government inventions were not commercialized. To encourage licensing of government patents, Congress built incentives into the Federal Technology Transfer Act. Government inventors and the laboratories where they work share part of the royalties generated from the commercial use of their inventions. The inventor and the labs profit through this commercialization and our economy is enhanced through manufacturing and sale of new products.

There are benefits to the public from the exchange of knowledge and products within the government. Exchange includes sharing information and products with other federal agencies, as well as with state and local governments. By sharing knowledge and products on a wide basis, the public reaps the benefits from research conducted for one purpose or agency in many new ways. The return on the investment of the tax dollar is increased.

Another benefit from the Federal Technology Transfer Legislation is the establishment of the Federal Laboratories Consortium. (FLC). This consortium is a network of over 500 federal labs. The FLC is a clearinghouse for technology transfer and a source for helping agencies learn how to transfer technology. NAVAIRWARCENTRASYSDIV is a member of the FLC.

NAVAIRWARCENTRASYSDIV has a long history of technology transfer to both the public and private sectors. For example, the overhead projector was developed under a NAVAIRWARCENTRASYSDIV contract in 1944 to project plot charts for navigation training. The overhead projector is used in nearly every classroom.

Today, NAVAIRWARCENTRASYSDIV is actively pursuing technology transfer through a number of initiatives. Some of the key initiatives are described below.

<u>COOPERATIVE R&D AGREEMENTS (CRADA's)</u>. NAVAIRWARCENTRASYSDIV currently has eight CRADA's:

o MOTOROLA - Motorola and NAVAIRWARCENTRASYSDIV are jointly developing a network interface unit to support Distributed Interactive Simulation.

o ENCORE COMPUTER CORPORATION - Encore Computer Corporation and NAVAIRWARCENTRASYSDIV are demonstrating and evaluating the portability of simulation software to Encore equipment and assessing conformance to DIS protocols.

o DIGITAL EQUIPMENT CORPORATION (DEC) - DEC and NAVAIRWARCENTRASYSDIV are demonstrating and evaluating the portability of simulation software to DEC equipment in support of DIS.

o SBS ENGINEERING - SBS Engineering and NAVAIRWARCENTRASYSDIV will cooperate in the application of research methods to demonstrate and evaluate firearms training systems for commercial applications.

o EMBRY RIDDLE AERONAUTICAL UNIVERSITY - Embry Riddle Aeronautical University and NAVAIRWARCENTRASYSDIV are evaluating a Radio Instruments Orientation Trainer (RIOT). NAVAIRWARCENTRASYSDIV placed RIOT at Embry Riddle Aeronautical University, and Embry Riddle Aeronautical University used RIOT as part of their instruction. NAVAIRWARCENTRASYSDIV will benefit from the formal evaluation of RIOT, with the potential for civilian commercial application. The University benefitted from the use of RIOT and from this research opportunity.

o UNIVERSITY OF CENTRAL FLORIDA/INSTITUTE FOR SIMULATION AND TRAINING - Through this CRADA, NAVAIRWARCENTRASYSDIV and UCF/IST are using Computer Assisted Software Engineering (CASE) tools to evaluate simulation software. NAVAIRWARCENTRASYSDIV has expertise in the use of CASE tools for simulation software evaluation. This agreement is benefitting the Navy by providing NAVAIRWARCENTRASYSDIV with trained individuals to conduct software evaluations and by providing access to additional CASE tools for software evaluations. Through this CRADA, UCF/IST is increasing their level of expertise in this area.

o LORAL DEFENSE SYSTEMS-AKRON - NAVAIRWARCENTRASYSDIV and Loral Defense Systems-Akron will perform R&D on the development and evaluation of a prototype cockpit training system applying Helmet Mounted Display (HMD) technology. NAVAIRWARCENTRASYSDIV has conducted R&D in HMD and has several patents. Loral is experienced in the development of low-cost cockpit training systems and high speed, high capability advanced cockpit training simulators. The CRADA will involve the development, integration, and testing of the combination of simulation software and databases, simulation crew station hardware, and simulation Helmet Integrated Display (HID) hardware, to evaluate the viability of the HID application in simulator devices.

o DYNAMICS RESEARCH CORPORATION - NAVAIRWARCENTRASYSDIV and Dynamics Research Corporation (DRC) developed a software shell which enables instructors to quickly generate educational games. The government version of the software is Quizshell. DoD personnel can obtain Quizshell by calling Janet Weisenford (407-380-8276) or Sonia Graham (407-380-8256). Quizshell is being used by a number of DoD agencies including the Navy Test Pilot School and in Army armor training. Gameshell is the commercial version which has been sold to schools nationally. Copies of Gameshell are available free to schools in Seminole and Orange Counties, Florida because of their involvement in the design and evaluation of the software. NAVAIRWARCENTRASYSDIV conducted an experiment assessing the impact of the game on knowledge retention and found that there was a significant positive improvement in knowledge retention in comparison to traditional study methods.

SCHOOL YEAR 2000. School Year 2000 is an initiative of the Florida Department of Education and the Center for Educational Technology at Florida State University to design and implement new models of schooling. NAVAIRWARCENTRASYSDIV is assisting with this project as a member of the Policy Advisory Board.

MEMORANDUM OF UNDERSTANDING (MOU). Current MOU's involving technology transfer include:

    o NASA, KENNEDY SPACE CENTER (KSC) - The Navy is sharing correspondence and computer base training materials and is assisting with computer based training system design and evaluation. NASA, KSC is providing access to subjects in support of Navy research on external factors influencing training effectiveness and access to technical experts in the areas of ADA, networking and telecommunication. NASA is also allowing NAVAIRWARCENTRASYSDIV to participate in NASA funded training for Interactive Courseware development.

    o FEDERAL AVIATION ADMINISTRATION (FAA) - NAVAIRWARCENTRASYSDIV will provide advisory and consulting services in simulation and training. FAA will provide consulting and advisory services in a variety of areas including multimedia implementations and Computer Based Instruction.

LOCAL TECHNOLOGY TRANSFER

    o MAITLAND MIDDLE SCHOOL - NAVAIRWARCENTRASYSDIV is a member of Maitland Middle School's Educational Technology Committee. The school is expanding its use of computers as tools for teaching.

    o EDGEWATER HIGH SCHOOL'S ENGINEERING CENTER - In 1991, Edgewater High School was designated an engineering educational center for high school students in Orange County Florida. The program is dedicated to increasing the number of students pursuing careers in science and engineering. Introductory as well as college level courses in engineering and science are offered at Edgewater. NAVAIRWARCENTRASYSDIV is an advisor to this program, in addition to providing adjunct faculty, mentors, training and laboratory experiences.

BENEFITS FROM TECHNOLOGY TRANSFER

In addition to the sharing of federally funded research and enhanced commercialization of government inventions, there are other benefits from technology transfer. By sharing Navy training research with the non-DoD public sector, improvements in training and education will occur. The benefits are not just "one way." NAVAIRWARCENTRASYSDIV is gaining access to subject matter experts and resources. We are also learning about civilian resources which can be shared with the Navy, such as the public school's teletraining network. NAVAIRWARCENTRASYSDIV is receiving feedback on its R&D products which can be used to improve future systems. Through the CRADA's, the Navy is gaining R&D products as well as expanding our research resources. In turn, the Nation is benefiting from new commercial products and additional employment opportunities.

TERMS OF REFERENCE

APP	Acoustic Performance Prediction
ASC	Automatic Scenario Control
ASG	Automatic Scenario Generator
ATC	Air Traffic Control
ATO	Afloat Training Oranization
CASE	Computer Assisted Software Engineering
CNO	Chief of Naval Operations
CIG	Computer Image Generation
CRADA	Cooperative Research and Development Agreement
CRT	Cathode Ray Tube
DEFTT	Decision Making Evaluation Facility for Tactical Teams
DIS	Distributed Interactive Simulation
DSP	Digital Signal Processor
DTIC	Defense Technical Information Center
DoD	Department of Defense
DTATS	Deployable Tactical Aircraft Training System
EWCAP	Electronic Warfare Continuum Assessment Program
ET	Embedded Training
FLC	Federal Laboratories Consortium
GFMPL	Geophysics Fleet Mission Profile Library
HID	Helmet Integrated Display
HMD	Helmet Mounted Display
IG	Intelligent Gateway
IR	Independent Research
ITS	Intelligent Tutoring System
I/ITSEC	Interservice/Industry Training Systems and Education Conference
IUSS	Integrated Undersea Surveillance System
LCD	Liquid Crystal Display
LFA	Low-frequency Active
MOU	Memorandum of Understanding
NCCOSC/NRAD	Naval Command and Control Ocean Surveillance Center R&D
NIU	Network Interface Unit
NVD	Night Vision Devices
NVG	Night Vision Goggles
PDU	Protocol Data Unit
R&E	Research and Engineering
RIOT	Radio Instruments Orientation Trainer
SBIR	Small Business Innovative Research
SpWS	Signal Processing
SWOS	Surface Warfare Officers School
TACTICS	Tactical Training Instructor Components
TCTS	Tactical Combat Training System
TEFL	Training Exercise Force Lay Down
VE	Virtual Environment
WTET	Weapons Team Engagement Trainer